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ABSTRACT

Described are the programs, services, and facilities available from the Environmental Learning Center (ELC). The relationship the Center establishes with schools using the facilities is presented and means of integrating the environmental education offerings of the Center into a school's curriculum are suggested. Also presented are complete lesson outlines for specific activities available at ELC, arranged according to who will be primarily responsible for directing the activity - student, intern, or naturalist. An activity site map is provided indicating the sites of specific activities on the Center's grounds. (RE)

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PLANNING GUIDE AND CURRICULUM

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SE 030 506

Introduction to the ELC

History

The Environmental Learning Center began in 1971 when a federal grant was received to open the then-closed Isabella Job Corps camp as a resident Environmental Learning Center. When the three year grant concluded, the Center was able to continue as a self-supporting outdoor school. The Center is a non-profit Minnesota corporation and is under the jurisdiction of a board of directors.

Each year over ten thousand students spend an average of five days living and learning at the ELC. During the academic year, schools from throughout Minnesota conduct extended environmental education programs at the Center. These programs involve students, parents, teachers and the Center staff. Many schools use the Center to conduct summer sessions, and weekends throughout the year are scheduled with special programs for young people and adults.

The Center's Goals

The ELC is dedicated to:

1. Giving young people greater opportunities to develop and further their interest in the natural and physical sciences, in ecology, in environmental studies and in the conservation of natural resources.
2. Promoting a quality environment through programs of environmental education.
3. Encouraging the recognition of environmental education as a process which combines the subject areas of math, social studies and science with ethics, aesthetics and recreation.
4. Rekindling the concept of stewardship.

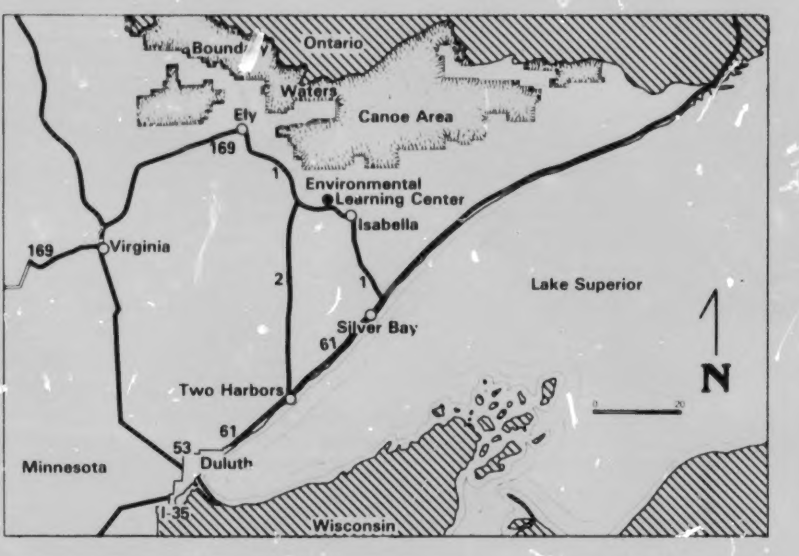
The ELC

The Environmental Learning Center is very well known to thousands of Minnesota youngsters and adults as the "ELC". Located in Minnesota's Arrowhead Country, the ELC provides an excellent natural environment and considerable instructional help for schools from throughout Minnesota that use the Center for environmental education programs. Surrounded by the Superior National Forest, students are able to use many square miles of undeveloped woodlands for learning. Lakes and streams are within walking distance of the Center, and many miles of trails provide all-season access to nature's classrooms.

Maps

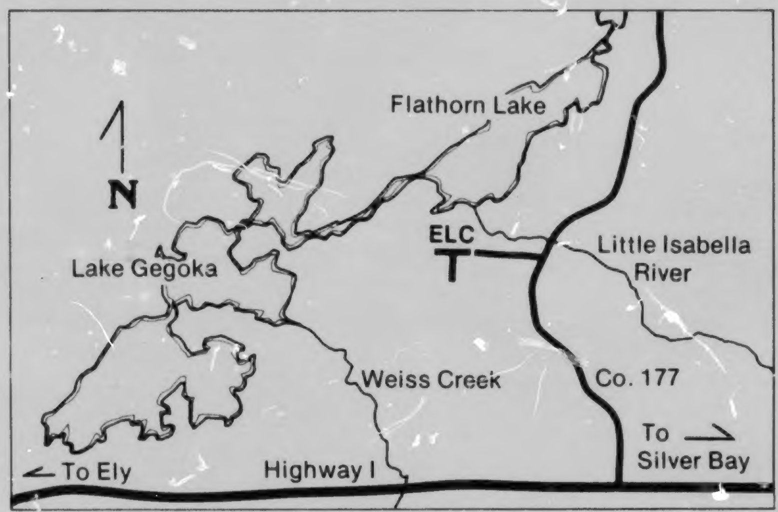
Location

The Center is located approximately 85 miles from Duluth and about 230 miles from the Twin Cities. All of the roads leading to the ELC are paved and well maintained. County Road Two North from Two Harbors provides the quickest route. Traveling along the lake to Highway One will enable students to enjoy some of Lake Superior's finest shore scenery. A non-stop trip from the Twin Cities will usually take about five hours. More time should be allowed if the trip is taken during the winter.



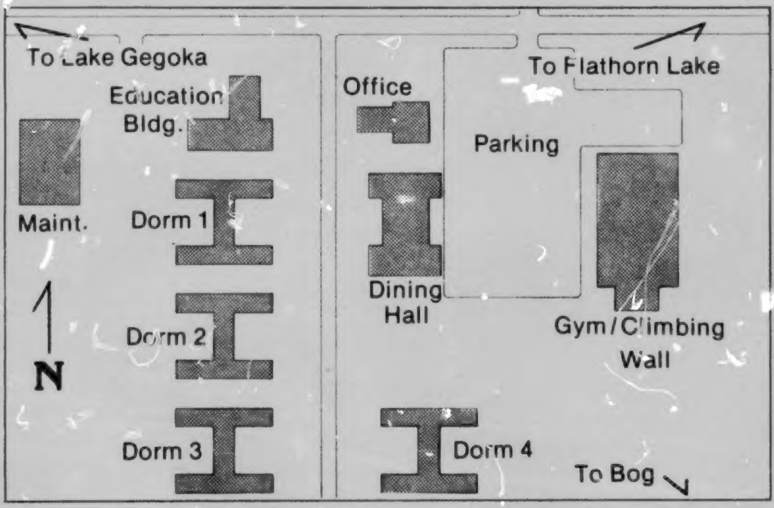
Environs

Flathorn Lake, the Little Isabella River and Lake Gegoka are all within walking distance of the ELC. These bodies of water provide all season learning environments and are used in many ways. The forests surrounding the Center contains many miles of trails and a number of campsites which are used by the Center participants.



Facility

Dormitories, classrooms, a gym with the North Country's finest indoor climbing wall and support facilities are all located at the ELC. Prior to arrival each group is assigned space as needed.



All correspondence should be addressed to:

Environmental Learning Center. Inc.
Box 191-A
Isabella, Minnesota 55607
218-323-4345 or 218-323-4785

A Team Approach to Environmental Education

The School and the Center
Due to the Center's approach to environmental education, hundreds of Minnesota teachers consider themselves contributors to the growth and development of the ELC. While the Center provides much, the visiting schools must provide more. Very often it is the visiting staff that initiate methods and concepts which in time become common to all groups using the ELC. The responsibilities of the Center and the schools, briefly stated, follow.

Center Responsibilities

Curriculum The ELC provides activity outlines for Naturalist instructed courses. Intern instructed courses and for a number of courses which may be used by the visiting school staff. The curriculum is designed for the season in which it is to be taught and most schools find that the ELC provided materials are adequate for a complete outdoor environmental education program.

Naturalists are assigned to teach activities for each visiting school group. The school coordinator may decide which activities are to be taught from a selection of naturalist activities available for each season.

Interns as instructors and aides are provided to each school by the Center. The number of Interns assigned is based upon the total number of students from each school.

Equipment needed for the activities provided by the ELC is furnished with two exceptions. Expendable items, such as paper, paints, pencils, etc., are not provided. Recreation equipment, including skis, snowshoes and canoes are assigned to each school based upon the total number of students rather than by the activity. It is normally safe to assume that enough of each will be provided to accommodate one third of the total number of students at a time.

Coordination at the Center is the responsibility of a member of the ELC staff. The Program Coordinator will be responsible

(continued next page)

School Responsibilities

Curriculum Schools may utilize their own curriculum as well as those available at the ELC. With ELC provided activities the equipment needed to conduct the activity is provided. With other activities, the equipment will be provided if available. Some activities, such as shooting sports, cannot be accommodated at the Center.

Teachers from the visiting schools are required to teach activities and be responsible for all aspects of the program not specifically assigned to the Center. Teachers may also aid the Center Interns or request that an Intern aid them.

Parent helpers are the rule with most school groups. Ideally there will be one parent for every instructor resulting in two adults for every twenty students. The Center's curriculum is complete enough so that the parents may comfortably serve as teachers or aides.

Coordination for the school program should be the responsibility of one person from the school. This individual should be responsible for all phases of scheduling.

Scheduling is the responsibility of the school program coordinator. With the help of the Center Program Coordinator, a schedule must be completed well in advance of arrival. Scheduling will include assignment of classes, teachers, parents, interns, naturalists, evening activities and more. The final

(continued next page)

Center Responsibilities [cont'd.]

for all Center related concerns and see that everything the school needs and is entitled to is provided.

Dorms provide the sleeping spaces. Each dorm holds 106 students with separate facilities for 53 in each of two wings. Schools with less than 100 students are normally assigned one dorm with males in one wing and females in another. Schools with more than 100 are assigned 2 dorms with males in one dorm and females in the other. Students must provide bedding (normally sleeping bags).

Food is served in the dining hall, cafeteria style. Meal times normally start at 7:30 a.m., noon and 5 p.m. Bag lunches may be requested as may early lunches on departure days. Trail meals are provided for the camping activities.

Classrooms are provided and their assignment is the responsibility of the Center Program Coordinator.

Evening Programs are presented each Tuesday and Thursday evening by the Center Naturalists. These programs are intended for all groups and each group should send chaperones. On Wednesday evening films are shown for all students. Teachers and parents, with the exception of a chaperone for each group, are invited to join the Center staff for coffee and visiting.

School Responsibilities [cont'd.]

schedule must be received by the ELC no less than 15 school days prior to arrival.

Transportation to and from the Center is the school's responsibility. Coach type buses are highly recommended as they shorten the trip. The Center will, upon request, provide the names of bus companies that have provided satisfactory service for others. Each school is also responsible for providing a vehicle for emergencies while at the Center.

Fees are the responsibility of the visiting school. Normally part of the fee is assumed by the school district and the balance is obtained from other sources. PTA's, fund raisers and charges to students are frequently used. Students that qualify for free or reduced meal prices will be assessed fees based upon the reduction, if a typed list of those eligible is presented to the Center prior to departure and final billing.

Forms required are relatively few. The major information form will provide all that is needed to assure that the Center is prepared to provide the service you expect.

Student Workers are required to help with kitchen duties. Each school should schedule one student for each fifteen in the total group for each meal. Brooms are provided in the dorms and classrooms and students should be assigned the responsibility for sweeping after each use. Prior to departure each group should pick up litter that may be located near their dorms and classrooms, as well as clean the sleeping area used.

ELC Naturalists

The Center Naturalists instruct a variety of specialized classes for students from the schools that use the ELC. Each day Naturalist classes are conducted during the morning and afternoon. Twice each week, on Tuesday and Thursday evening, Naturalist programs are presented for all students. The evening presentations are usually entertaining as well as educational.

Naturalist Activities
Activities instructed by the Naturalists include seasonal variations of a variety of topics. The Naturalist activities, like all of those provided by the ELC, are designed to take approximately 3 hours, or a half day.

Each activity has a lesson plan which may be copied for the students. The lesson plan indicates the method of instruction as well as the learning objectives. Teachers may, if they wish, evaluate the students on the basis of the lesson plan.

Naturalist Assignments
Naturalists will be assigned to instruct a specific number of activities for each group. The number of assignments is based upon the number of students in the total group. Because the Naturalists will be assigned to work with all of the schools in attendance at a given time, the Center must reserve the right to assign the times that they will be available to each school.

A school may select **one instructional period** for each **20** participants if the group stay is for **five days**. For example, if Jefferson School is bringing 175 students to the ELC for 5 days, Jefferson will be entitled to 8 Naturalist sessions.

A school may select **one instructional period** for each **30** participants if the group stay is for **three days.** For example, if Washington School is bringing 120 students for 3 days, Washington will be entitled to 4 Naturalist sessions sometime during the 3 day stay.

Scheduling will be completed upon receipt of participant number and length of stay. The schedule at right is similar to that which would be forwarded to a school scheduled to bring 200 students to the ELC for 5 days. 10 sessions have been assigned, with 2 beginning on Monday afternoon, 2 scheduled for Tuesday morning and so on.

Naturalists' Schedule

	M	T	W	T	F
Morning		2	2	2	-
Afternoon	2	1	1	-	

ELC Interns

College students are utilized by the Center to provide a variety of instructional functions. The Interns, enrolled for credit, represent colleges from throughout the country and their stay at the Center generally coincides with the academic sessions of their schools. The Interns serve as instructors, instructor aides and as liaisons for the schools that use the Center. Normally there are from six to nine Interns in residence at the ELC at any given time.

Interns Serve as Instructors

Part of the Center's curriculum includes intern activities. These activities are in the areas of skills, crafts and basic ecology. Prior to being assigned as instructors the Interns receive training in these areas which enables them to serve as lead instructors. Because of the need for a low student-teacher ratio it is necessary that the school provide one assistant for intern instructed classes that are conducted for more than ten students.

Interns Serve as Teachers' Aides

Frequently, because the Interns are familiar with the area and many methods, it is advantageous to schedule them as aides for new or first time activities. While the Intern expects to be called upon to provide meaningful input, the responsibility for the activity and the students belongs to the staff person from the visiting school.

School/Center Liaison

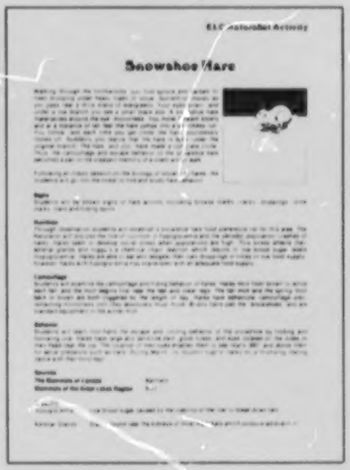
An Intern liaison is assigned to each school. As liaison the Intern will serve as the ELC staff person most aware of each school's program and needs. During each school's stay at the ELC, the liaison will be available each day to meet with the school program coordinator to assure that all aspects of each school's program are functioning as well as possible.

Intern Assignment

Intern assignment criteria is based upon the chart on the right. Occasionally additional Interns will be available, however, the extras should not be assumed in preparing a schedule. Flexibility is needed because schools do not schedule at the same time and frequently the total Intern need for a given period is not known until just before the schools arrive.

Students	Interns
20- 40	1
41- 80	2
81-120	3
121-160	4
160-200	5
201 or more	6

Curriculum Available from the ELC


ELC Naturalist Activity

Snowshoe Hare

The ELC provides a large selection of environmental education activities for the schools that use the Center. The materials may be used exclusively or they may be used to supplement material and activities obtained elsewhere.

Center curriculum is intended for **four** different instructional methods.

I **Naturalist activities** are designed to be instructed by ELC Naturalists.
II **Intern activities** are designed to be instructed by ELC Interns, often with help from a visiting staff person.
III **ELC activities** are intended for use by the schools that use the Center. These activities may be instructed by the visiting staff with or without help from ELC Interns.
IV All of the activities may be used for instructional purposes with the instruction provided by the visiting school staff.

Curriculum Lists
Seasonal curriculum lists will be forwarded to schools requesting them.

Winter activities are designed primarily for December through March.
Spring activities are intended for April-May.
Summer activities are intended for June-August
Fall activities are intended for September through early November.

The following **Winter List** includes some of the activities for that season:

Naturalist Activities
- Snowshoe Hare
- Deer Study
- Winter Plants
- Beaver Study
- Animal Signs

Intern Activities
- Rock Climbing
- Skiing
- Basket Weaving
- Camping Skills
- Orienteering and Snowshoeing

General Activities
- Plant Key Race
- Winter Plant Adaptations
- Ecology Games
- Winter Mammals
- Snow

Supplies:
Education Equipment, Clothing Lists

The ELC normally provides all of the non-expendable education equipment needed to conduct Center activities. The list of equipment assigned to each school will be determined only after a complete activity schedule is received from the school's coordinator.

Equipment available at the Center is in quantities sufficient to outfit two groups of students involved in each of the activities provided as Center Curriculum. In the case of recreation equipment there is normally more. School groups will be assigned skis, snowshoes, canoes and camping gear adequate for one third of the total number of students. For example, a group with 120 students would be assigned 40 pairs of skis and 40 pairs of snowshoes, or 12 canoes, depending on the season.

Equipment Use Rules

1. Equipment must be prearranged and check-in and out is the responsibility of the school coordinator. Equipment will not be checked in or out via students.
2. Broken, damaged or dirty equipment will not be accepted unless appropriate charges have been determined and agreed upon. The only charge for use of ELC equipment is based upon the cost of cleaning, repair and replacement.
3. In case of an emergency, the Center liaison may be contacted to provide additional or supplemental equipment, if it is available.

Schools must furnish all expendable items and other equipment not specifically provided by the ELC.

Clothing Needs
Spring, Summer and Fall - Rain gear, tennis shoes, boots, jacket, sweater, pants, socks, swimsuit, changes of underwear.

Winter - Long underwear, warm stockings, winter boots, a heavy sweater, heavy shirts, a warm jacket or snowmobile suit, two pairs of mittens, a heavy stocking cap, at least two pairs of heavy trousers and a scarf are essential for winter comfort. A pair of tennis shoes and a second pair of boots are also needed.

Students must furnish all personal needs including bedding (a sleeping bag and pillow), soap, towels, tooth brush and paste, clothing and seasonal needs like bug spray and sun glasses.

General Scheduling Information

Preliminary School Information

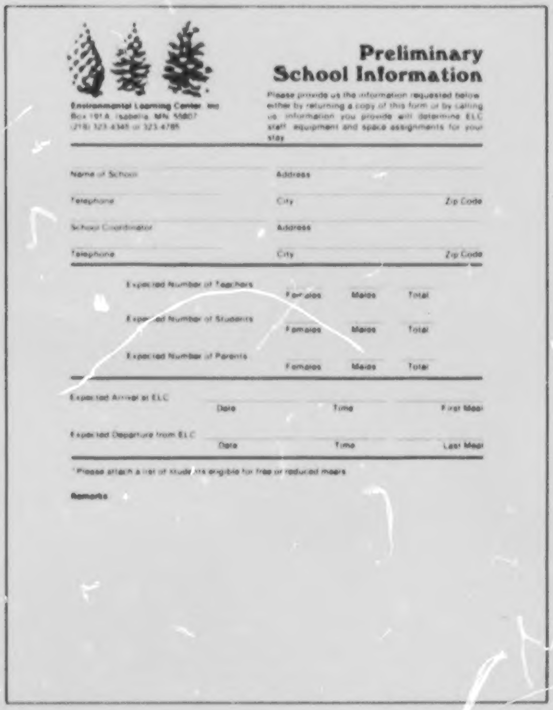
Once the school has decided to visit the Center, preliminary school information should be provided as soon as possible by the school's coordinator. Forms, such as shown below, are provided, or the information may be called in.

Frequently the numbers of students are not known exactly until departure day, however, for the purpose of planning, all the information required should be provided according to the school's expectations.

Preliminary ELC Information

Once the preliminary school information is on hand, the ELC can provide the school with information regarding scheduling of staff helpers, quantities of equipment available, and gym use. The form shown below is used to relay this information.

In most cases this information exchange is completed at the time of initial contact, and often as much as a year in advance!



Environmental Learning Center, Inc
Box 191A, Isabella, MN 55807
(218) 323-4345 or 323-4785

Preliminary School Information

Please provide us the information requested below either by returning a copy of this form or by calling us. Information you provide will determine ELC staff, equipment and space assignments for your stay.

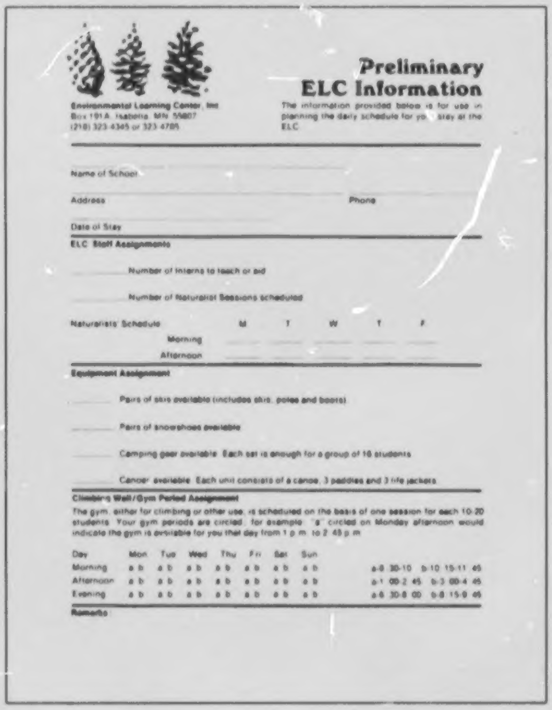
Name of School ______ Address ______
Telephone ______ City ______ Zip Code ______
School Coordinator ______ Address ______
Telephone ______ City ______ Zip Code ______

Expected Number of Teachers ______ Females ______ Males ______ Total
Expected Number of Students ______ Females ______ Males ______ Total
Expected Number of Parents ______ Females ______ Males ______ Total

Expected Arrival at ELC ______ Date ______ Time ______ First Meal
Expected Departure from ELC ______ Date ______ Time ______ Last Meal

*Please attach a list of students eligible for free or reduced meals.

Remarks



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Box 191A, Isabella, MN 55807
(218) 323-4345 or 323-4785

Preliminary ELC Information

The information provided below is for use in planning the daily schedule for your stay at the ELC.

Name of School ______
Address ______ Phone ______
Date of Stay ______

ELC Staff Assignments

______ Number of Interns to teach or aid
______ Number of Naturalist Sessions scheduled

Naturalists' Schedule	M	T	W	T	F
Morning					
Afternoon					

Equipment Assignment

______ Pairs of skis available (includes skis, poles and boots)
______ Pairs of snowshoes available
______ Camping gear available. Each set is enough for a group of 16 students.
______ Canoes available. Each unit consists of a canoe, 3 paddles and 3 life jackets.

Climbing Wall/Gym Period Assignment

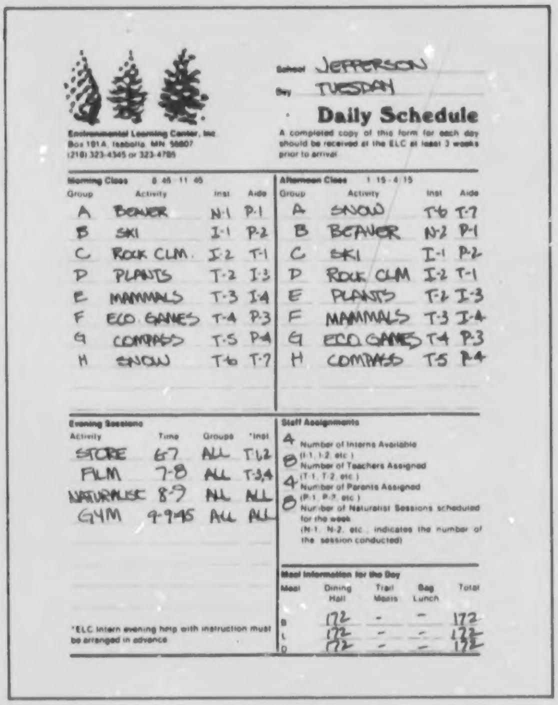
The gym, either for climbing or other use, is scheduled on the basis of one session for each 10-20 students. Your gym periods are circled; for example, "a" circled on Monday afternoon would indicate the gym is available for you that day from 1 p.m. to 2:45 p.m.

Day	Mon	Tue	Wed	Thu	Fri	Sat	Sun	
Morning	a b	a b	a b	a b	a b	a b	a b	a-8:30-10 b-10:15-11:45
Afternoon	a b	a b	a b	a b	a b	a b	a b	a-1:00-2:45 b-3:00-4:45
Evening	a b	a b	a b	a b	a b	a b	a b	a-6:30-8:00 b-8:15-9:45

Remarks

Daily Schedule

A completed copy of the Daily Schedule Form for each day should be at the ELC at least 3 weeks prior to your arrival. A sample schedule is shown at right.



Environmental Learning Center, Inc
Box 101A, Isabella, MN 55607
(218) 323-4345 or 323-4785

School JEFFERSON
Day TUESDAY

Daily Schedule

A completed copy of this form for each day should be received at the ELC at least 3 weeks prior to arrival

Morning Class 8:45 - 11:45

Group	Activity	Inst	Aide
A	BEAVER	N-1	P-1
B	SKI	I-1	P-2
C	ROCK CLM.	I-2	T-1
D	PLANTS	T-2	I-3
E	MAMMALS	T-3	I-4
F	ECO GAMES	T-4	P-3
G	COMPASS	T-5	P-4
H	SNOW	T-6	T-7

Afternoon Class 1:15 - 4:15

Group	Activity	Inst	Aide
A	SNOW	T-6	T-7
B	BEAVER	N-2	P-1
C	SKI	I-1	P-2
D	ROCK CLM	I-2	T-1
E	PLANTS	T-2	I-3
F	MAMMALS	T-3	I-4
G	ECO GAMES	T-4	P-3
H	COMPASS	T-5	P-4

Evening Sessions

Activity	Time	Groups	*Inst
STORE	6-7	ALL	T-1,2
FILM	7-8	ALL	T-3,4
NATURALIST	8-9	ALL	ALL
GYM	9-9:45	ALL	ALL

*ELC intern evening help with instruction must be arranged in advance

Staff Assignments

4 Number of Interns Available (I-1, I-2, etc.)
8 Number of Teachers Assigned (T-1, T-2, etc.)
4 Number of Parents Assigned (P-1, P-2, etc.)
8 Number of Naturalist Sessions scheduled for the week (N-1, N-2, etc., indicates the number of the session conducted)

Meal Information for the Day

Meal	Dining Hall	Trail Meals	Bag Lunch	Total
B	172	-	-	172
L	172	-	-	172
D	172	-	-	172

Sample Schedule Explanation
The school is staying at the ELC for five days. There are 160 students, eight teachers and four parents. Four ELC Interns are assigned, and eight Naturalist sessions are scheduled for the week. Each teacher is instructing just one class and then repeating the same class for a different group of students. During the week, beginning on Monday afternoon and ending on Friday morning, a total of eight half day sessions (not including the evening sessions) will be instructed. Each of the eight groups of students will experience each of the eight activities. Notice that only seven teachers are assigned. It is likely that the 8th teacher will be called upon to teach an activity in order to give the other staff a session free or to teach the 8th activity during those times when a Naturalist is not available. This sample indicates that a Naturalist was not available on the previous afternoon, as sessions one and two of the eight available are being conducted on this schedule day.

During the evening students may use the Center's store after supper. This is followed by a film provided by the ELC and shown by an Intern to all students. The Intern's only function is to show the film and answer questions. Adults from the school must be present. The film is followed by an ELC Naturalist program. Again, adults from the school must be in attendance. The gym session is conducted during a time that was assigned by the ELC Program Coordinator and the gym activity was determined by the school instructors.

Environmental Learning Center, Inc.
Box 191A, Isabella, MN 55607
(218) 323-4345 or 323-4785

School ____________________

Day ____________________

Daily Schedule

A completed copy of this form for each day should be received at the ELC at least 3 weeks prior to arrival.

Morning Class 8:45 - 11:45

Group	Activity	Inst.	Aide

Afternoon Class 1:15 - 4:15

Group	Activity	Inst.	Aide

Evening Sessions

Activity	Time	Groups	*Inst.

*ELC Intern evening help with instruction must be arranged in advance.

Staff Assignments

____ Number of Interns Available (I-1, I-2, etc.)
____ Number of Teachers Assigned (T-1, T-2, etc.)
____ Number of Parents Assigned (P-1, P-2, etc.)
____ Number of Naturalist Sessions scheduled for the week. (N-1, N-2, etc., indicates the number of the session conducted)

Meal Information for the Day

Meal	Dining Hall	Trail Meals	Bag Lunch	Total
B				
L				
D				

Names, Rules and Extras

Staff Names

Designations, (T-2, P-3, etc.) should be used in preparing the daily schedules.

Teachers	Parents	ELC Interns	ELC Naturalist Session/ Instructor
T-1 ____________	P-1 ____________	I-1 ____________	N-1 ____________
T-2 ____________	P-2 ____________	I-2 ____________	N-2 ____________
T-3 ____________	P-3 ____________	I-3 ____________	N-3 ____________
T-4 ____________	P-4 ____________	I-4 ____________	N-4 ____________
T-5 ____________	P-5 ____________	I-5 ____________	N-5 ____________
T-6 ____________	P-6 ____________	I-6 ____________	N-6 ____________
T-7 ____________	P-7 ____________	I-7 ____________	N-7 ____________
T-8 ____________	P-8 ____________	I-8 ____________	N-8 ____________
T-9 ____________	P-9 ____________		
T-10 ____________	P-10 ____________		

ELC Rules

- Each group will be assigned specific dorms and classrooms. All other areas are off-limits as they are for other uses.
- No outside activity is permitted after 10 p.m.
- No smoking is permitted in the dorms, classrooms, dining hall or gymnasium.
- Each group is expected to sweep and pick up in the dorms and classrooms used.
- Dorm check in and out time is immediately following lunch on the arrival and departure day. Earlier arrival or later departure is occasionally possible but must be requested in advance.
- Groups that number less than 40 may be required to share a dorm.
- Center staff area, maintenance shops and sewage plant are off-limits.
- Schools will be billed for any damage resulting from their activities.
- Schools must supply kitchen help consisting of students and one adult for each meal.
- Beds should not be moved, mattress covers must not be removed and curtains should remain as found.

Moving groups in and out of dorms on time requires a great deal of group cooperation and help.

Extras

- Birthday cakes will be provided if requested in advance.
- A good quality black-and-white action photo of your group will be provided for your use. Consider a story for the local newspaper.
- Finally, we will do all we can to assure that your group's stay at the ELC is the best experience of your school year! Let us know how we can serve you.

ELC Films

The ELC has a number of high quality films which will teach students about everything from energy to whales. These films will be shown at scheduled times by an ELC staff projectionist. Because the cost of films of this quality is high, we cannot allow non-staff to show the films.

You may request films from the following list:

Cry of the Marsh
15 minutes - color
The draining and filling of marshes is one of our largest environmental problems. This film shows some of the immediate effects of development on wildlife and offers a lesson on man's impact on our environment.

Death of a Legend
50 minutes 37 seconds - color
The wolf is yet another species threatened by man and his technology, but especially because of unfounded myths that have grown up around it. This film shows the true story of the wolf. The film contains some exceptional footage showing the wolf's life cycle and the social organization of the pack, as well as views of other animals of the wilderness - caribou, moose, deer, buffalo.

Double Basic
27 minutes 50 seconds - color
Taking along his son as his double partner, Bill Mason demonstrates all basic paddling strokes and how to use them in various combinations to direct the canoe at will. The film shows the application of these techniques in rapids, and emphasizes safety and the importance of working with a partner as a well coordinated team.

Energy Carol
10 minutes 33 seconds - color
Ebenezer Scrooge has a motto: to waste is to grow. Now his new motto becomes: back to basics. **The Energy Carol** traces this momentous transformation, and introduces us to the spirits of energy past, present and future.

In Search of the Bowhead Whale
49 minutes 25 seconds - color
An adventure film of a whaling expedition. The objective was to find and film the bowhead, dwindling behemoth of the cold arctic seas, brought to the edge of extinction by excessive commercial whaling. The expedition searches out and meets the bowhead and belugas and films the encounter for all to see.

The Rise and Fall of the Great Lakes
16 minutes 40 seconds - color
A lesson in geography which concludes that although the Great Lakes have had their ups and downs nothing has been harder to take than what man has done to them lately. In the film a lone canoeist lives through the changes of recent geological history only to find himself trapped in a sea of scum.

Paddle to the Sea
27 minutes 57 seconds - color
A children's odyssey - the journey of a handcarved toy canoeman from Canada's northern forest downstream to the distant sea. The film is from a story of the same name by Holling C. Holling, author of many children's books and a wilderness crafts and travel enthusiast.

Skinny Skis
15 minutes - color
Cross-country skiing, from the hot-dog racer to the farmer checking his cattle, is great fun. The winter woods is quiet, and the swishing of skis is a harmonious sound.

Solo
15 minutes - color
A solo climb to the top of a mountain is a grueling, dangerous, and rewarding experience. This film is a celebration on the joys of climbing and is not an example of how to climb safely.

The Spruce Bog
22 minutes 12 seconds - color
This film shows conditions under which a spruce bog is formed, with details of the plant types found at successive stages of development from open water to mature spruce forest. Time-lapse photography illustrates the growth and decay of vegetation preceding the appearance of the sphagnum moss that chokes off water to make the floor of the forest.

Temples of Time
26 minutes 45 seconds - color
A mountain is a living thing; it has an ecological balance, a process of evolution manifest in slow, subtle ways; but it is also subject to the ravages of man's technology. This picture brings to the screen magnificent footage of mountain solitudes and the wildlife found there, of natural splendor in all its changing moods.

Curriculum Calendar

The courses you will find on the following pages are listed here according to their appropriate season.

Naturalist Activities	Intern Activities	ELC Activities
FALL [August 15 - November 15]		
Animal Signs	Aquatic Chemistry	The Key Race
Aquatic Animal Behavior	Basketry	Ecology Games
Beaver	Basic Camping	Forest Communities/Birds
Bog Succession	Beginning Orienteering	Creative Writing
The Field Community	Beginning Rock Climbing	Plant Photosynthesis
Geology	River Volume and Velocity	
Lichens, Ferns and Mosses	Lake Flush Time	
Plant Medicines*	Beginning Canoeing	
Tree and Shrub Ecology	Soil Ecology	
Wild Edible Plants*		
Small Mammals		
Insect Ecology*		
Animal Senses		
Plant Transitions		
Animal Transitions		
WINTER [November 15 - April 15]		
Animal Signs	Basketry	The Key Race
Basic Survival	Basic Camping	Ecology Games
Beaver	X Country Skiing	Creative Writing
Snowshoe Hare	Beginning Orienteering	Tree Adaptations to Winter
Tree and Shrub Ecology	Beginning Rock Climbing	Winter Birds
White Tailed Deer	Snow Study**	Snow
Winter Plants	Winter Mammals**	Winter Mammals
Aquatic Animal Behavior		
SPRING [April 15 - June 1]		
Animal Signs	Aquatic Chemistry	The Key Race
Aquatic Animal Behavior	Basketry	Ecology Games
Beaver	Basic Camping	Forest Communities/Birds
Bog Succession	Beginning Orienteering	Creative Writing
Geology	Beginning Rock Climbing	Plant Photosynthesis
Lichens, Ferns and Mosses	River Volume and Velocity*	
Plant Medicines*	Lake Flush Time*	
Spring Warblers*	Beginning Canoeing*	
Tree and Shrub Ecology	Soil Ecology*	
Small Mammals		
Insect Ecology*		
Spring Wildflowers*		
Snowshoe Hare		
SUMMER [June 1 - August 15]		
Animal Signs	Aquatic Chemistry	Key Race
Aquatic Animal Behavior	Basketry	Ecology Games
Beaver	Basic Camping	Forest Communities/Birds
Bog Succession	Beginning Orienteering	Creative Writing
The Field Community	Beginning Rock Climbing	Plant Photosynthesis
Geology	River Volume and Velocity	
Lichens, Ferns and Mosses	Lake Flush Time	
Plant Medicines	Beginning Canoeing	
Spring Warblers*	Soil Ecology	
Tree and Shrub Ecology		
Wild Edible Plants		
Small Mammals		
Insect Ecology		
Spring Wildflowers		

*The asterisk indicates activities which may not be possible throughout the entire season. Please check with the Center.

**During the winter our interns will teach these ELC activities.

If you will need multiple copies of any curriculum materials please plan on making copies before you arrive at the Center. *The ELC does not provide student worksheets in quantity.*

Tree Adaptations to Winter

Studying trees in the winter is not often done outdoors. Winter trees aren't growing, they're not very colorful, and more often than not the winter wind will serve as an instant trigger for the shivers. To study plants in the winter it is best to provide all of the needed tools during an indoor session, and then venture outdoors.

In this activity students will learn about a number of adaptations which are necessary if trees are to survive winter. Students will (1) learn how a tree's shape affects its chances of survival, (2) better understand how plants use water to stimulate growth and adapt to the absence of water during the winter, and (3) age a number of trees and be able to make logical deductions about the tree's growth based upon observation of its habitat.

This activity is dependent upon the instructor with all of the needed information provided in this introduction. Much of the information must be presented during the indoor portion of the activity. Each student will need a copy of the student activity sheet, a hand lens and a clipboard.

Instructional Sequence

The student activity sheet has 3 sketches which deal with adaptations. Use the following information to help them answer the questions included with each sketch. Methods of aging trees are discussed, and then the activity moves outdoors to examine the impact of tree habitats.

Tree Shape

Tree shape is a determining factor in where trees grow and how well they can tolerate snow loading. Spire-shaped conifers hold less snow on individual branches and are best adapted to northern winters. The shape also permits easy unloading as the snow will naturally move downward with no branches to stop the movement once it starts. Trees mith multiple stems, like some aspen, birch and elm, usually have more breakage due to snow loading. Loading does not seem to effect the tops of tall trees, no matter what their shape. This is due primarily to the reduced size of the branches and the effect of wind. Throughout the discussion encourage students to hypothesize how shape relates to habitat.

Winter Adaptations

Winter adaptations which demonstrate water conservation include cork-like waterproof scales that cover the buds (next year's leaves and flowers), and the bark, which does not permit the loss of fluids from the twig. Evergreen trees do not lose all of their leaves (usually needle-like) during the winter. Their minimum surface area and waxy protective covering is an adaptation that permits them to be carried during the non-growing season. During the winter season roots cease to function. Their major role is to provide nutrients and water to the tree, and because the roots function at a lower temperature than the rest of the tree, they are the first to begin functioning in the spring.

Seasonal Growth

Growth is best demonstrated using the "tree slices" which are provided. The annual ring is actually an indication of growth during the spring and summer. The dark segment is summer growth and the thicker light segment on the inside is the spring growth. Trees grow most during the spring and don't grow at all during the fall and winter. Ask the students to complete the drawings. Note that there is heavy movement of water during the spring, almost none for fall, and none at all for winter

They should indicate that the topsoil is frozen and that moisture, in the form of snow, stays on the top of the ground during the winter.

Aging Trees
The annual rings represent the growth during the spring and summer. The rings are easily recognized due to the dark color of the summer growth. Counting whorls is fairly accurate for aging young conifers. Ask the students to age the cut-away in the picture (12 years) and the conifer (5 years). You may ask them to draw an arrow pointing to the summer wood which was formed three years ago to further judge their understanding of growth rings. Use of tree rings to determine past events (weather, fire, etc.) is called dendrochronology. Using the whorl method for aging conifers does not work for older trees because most scars will be covered over by bark. When the students have aged the illustration they are ready to hike to four sites and, under the direction of the instructor, age and examine trees.

Field Trip
Instruct the students to complete the chart included in the student worksheet. Growth rate can be determined by dividing age into the diameter. Habitat should indicate if the tree experienced ideal growing conditions. Ask the students to rate the habitat as "poor" "fair" or "good" for the tree and to list reasons for their choice.

Sites
Bog Located on the edge of the bog along the trail are well marked jack pine and black spruce sections. The annual rings will be very tight, due, not to lack of sunshine, but to the lack of nutrients available in the bog. (Sign #1: Jack Pine; Sign #3: Black Spruce.)

Mixed Forest The section is a jack pine. Compare this to the bog jack pine and discover that the mixed forest tree grew much faster. Both the nutrients available and the exposure to sun were factors. (Sign #2: Jack Pine.)

Sheltered Areas Sheltered wooded areas in the forest will produce countless numbers of small stunted spruce and balsam that have been denied adequate sunshine for years. Using a sharp jackknife, snip off one of these small trees and pass it around so that the students can age it with their hand lenses. Often a tree the size of a pencil will be over thirty years old. During the winter you may have to go to a sheltered area and dig a bit to find a specimen. (Look left of Sign #2.)

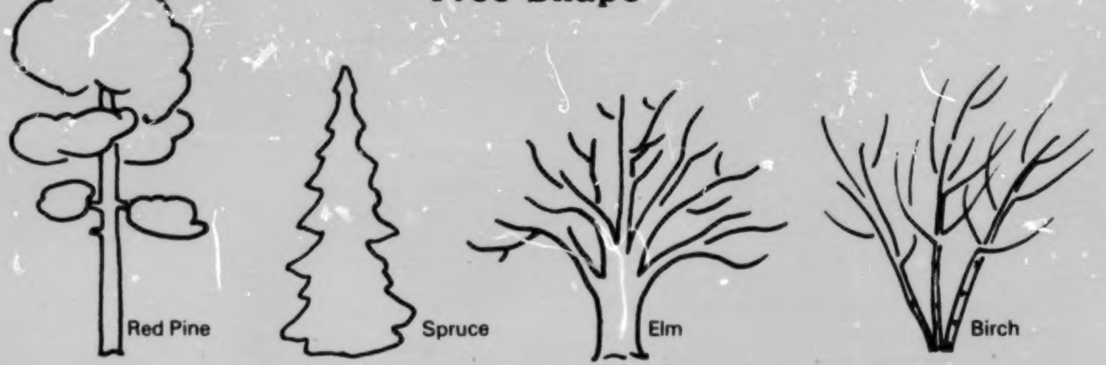
River Bottoms Stream edges and areas that are occasionally covered with water are good alder habitat. After checking the section, ask students to hypothesize as to why alders are located along stream beds. Alders are adapted to this type of habitat and serve a function. They grow fast and have a relatively short life span. They serve to stabilize wet areas and recover quickly if the habitat is disturbed. (Sign #7: Alder.)

Note: Refer to **ELC Activity Site Map** for locations, The signs are made from slices of tree trunks.

Summary
All of the activities in this lesson deal with adaptations. You may wish to have the students list as many examples as they can of ways that the trees studied have adapted to their environment.

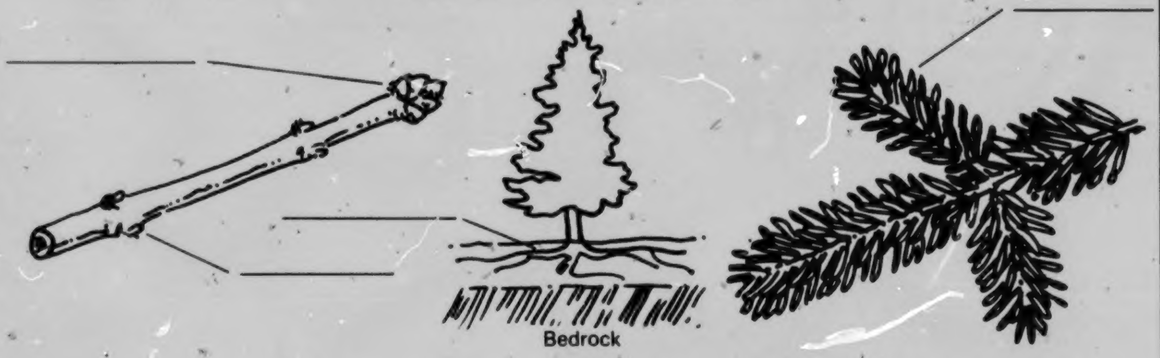
Tree Adaptations
Student Worksheet

Tree Shape



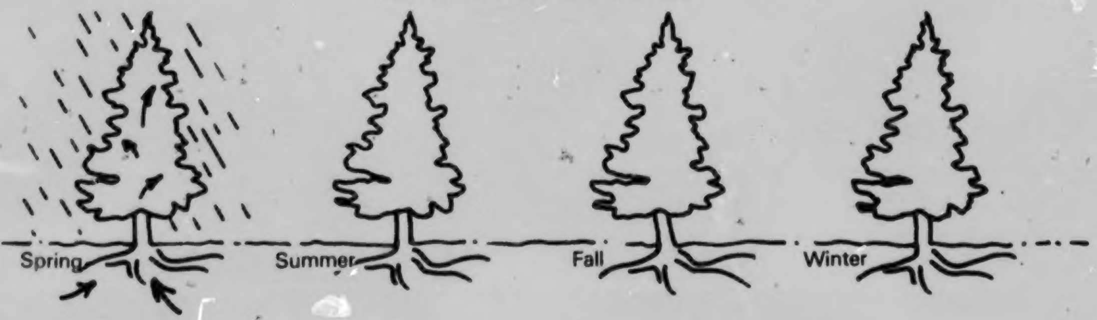
Shape has a great deal to do with where a tree will grow. Using the diagrams above, draw snow onto each tree and decide (1) which tree would most quickly be damaged, (2) which would best shed snow, (3) which would carry the least amount of snow due to wind action, and (4) which would hold the most snow without being damaged.

Winter Adaptations



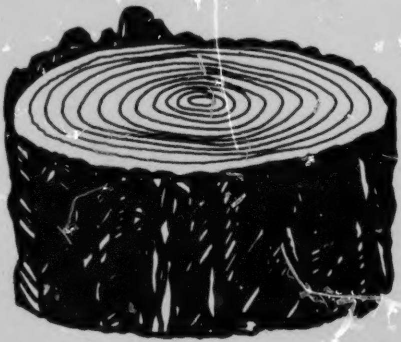
Label the above tree parts as they are discussed. Indicate how each part adapts during the winter.

Seasonal Growth



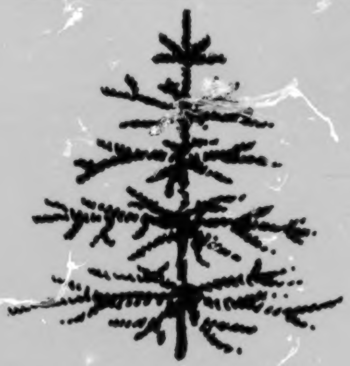
On this diagram "spring" is completed. Rain is falling and the water is moving through the tree, resulting in maximum growth. Draw in arrows similar to those on the spring diagram for the other seasons.

Aging Trees



How old are these trees?

Draw an arrow to the growth point of three years ago.



When looking at a tree cutaway to determine age, the dark ring is actually the summer growth and the larger light ring between it and the previous growth is the spring wood. During the fall and winter there is little or no growth at all. Determine how old the tree is by counting the growth rings. With young coniferous trees it is possible to determine age by counting the annual whorls.

Examining Habitats

Complete the following chart for each of the samples located in the four different habitats.

Site	Habitat	Age	Diameter	Growth Rate

Bog
The tree cutaways are jack pine and black spruce. What is indicated by comparing the growth rate of the two?

Mixed Forest
The cutaway is a jack pine. Is there a difference between this pine and the bog pine?

Sheltered Woodland
Locate a small spruce or balsam and determine the age. What might be the major reason for the very slow growth rate?

River Bottoms
Alders grow best along river bottoms. Alders grow fast and it is often difficult to find an old alder. What conditions make the river bottom an unstable habitat?

Creative Writing

Nature has always been a major source of inspiration for poets. From the earliest recorded poets to the most recent, nature figures prominently as a source of ideas, allowing these poets to express themselves in their own special ways. From Homer through Whitman to the last issue of The New Yorker, society has applauded its nature poets.

Using a classroom session on creative writing and a retreat into the forest, each student will discover and develop his own ability to write creative poetry, using nature as inspiration.

This creative writing exercise is designed to tap into each students creativity. It is not an exercise in penmanship or spelling. Students must be encouraged to get ideas down fast, not worrying about spelling or penmanship; these details can be worked out when their writings are being "cleaned up". The main object is to catch those fleeting ideas before they are irretrievably lost. Also, do not concern the students with writing rhyming poetry. Rhyme is too difficult for beginners who do not have enough experience with language to keep from letting rhyme control the flow of thought.

Instructional Sequence

There are four exercises in this activity. After a brief classroom introduction to the parts, find a place in the woods at which the group can meet and disperse. From this place each student should go into the forest and find an interesting natural form. A stump or fallen log is especially good if it is weathered, burned, split, mossy, etc. A large rock with lichens, ferns and mosses growing on it or an interesting configuration of earth or roots will also work well. Tell the students to use their nature objects for the following exercises. After each exercise, have the students return to the outdoor classroom and review the work.

Exercise #1

> **Write a physical description of your object for someone who is intensely curious about it, but has been blind since age four [so he will know colors]. Deal with all its physical characteristics and use all of your senses. What shapes? Colors? Textures? Smells? Tastes?**

Review Session: After writing for at least 20 minutes, call the students back to share what they have written. Call first on one or two gregarious individuals to get the sharing started and then continue until each student has had an opportunity to contribute. Listen carefully, be certain to make eye contact with each student, and ask to have certain sections or lines read again to be sure that the poems are really heard. React positively to powerful or unusual or catchy lines; ignore the weak ones. Make sure each student has received at least one positive comment on his writing before going on to exercise two.

Exercise #2

Preview Session: Before starting, encourage the students to take chances with their writing and to be as wildly imaginative as they can. Make sure they understand how to draw comparisons ("The red brick shone in the evening sun like an embarrassed boy"). You might look around the area and draw comparisons before you start the exercise. "What is this area like?" Accept responses and if necessary for clarity ask the responder why the image seems to fit.

> **Pretend the object is your mother or your father. One or the other, but not both. Now you must prove it. What characteristics of this object remind you of your mother [or father]? The shapes, colors, textures, smells, moods, etc., will remind you of characteristics of your parent. Show how these two very different things are really similar.**

Review Session: Use the same sharing process as before. Be sure to note the difference between the objective description in Exercise #1 and the subjective description in Exercise #2. Is one right and one wrong? When should these approaches be used? When responding to the students' works, use only positive comments, be very enthusiastic about fresh, non-cliche expressions and point out their freshness, their honesty, their individuality, etc.

Exercise #3

> **Look for characteristics and qualities that remind you of yourself. This may be something that you like very much about yourself, or possibly something that you do not like. Are you, like the object, a part of nature? Why or why not? Can you see your own lifestyle? Your temper? Your daydreaming?**

Review Session: Use the same sharing process as before, confining the sharing to those who want to share. Make sure that each student appreciates the process of comparing some personal something to some detail of nature. A stump to their mother or father, a leaf to their book report, a cliff to their sense of inferiority, a smooth stone to their pride, etc. Read one of the following poems by an established poet and ask the students to note how the poets related their work to nature.

For elementary students:
The Eagle, Alfred Lord Tennyson
In Just Spring, E.E. Cummings
The Lake Isle of Innisfree, William Butler Yeats
A Bird Came Down the Walk, Emily Dickenson
A Poison Tree, William Blake

For junior & senior high students:
Elegy for Jane, Theodore Roethke
Musee des Beaux Arts, W.H. Auden
Root Cellar, Theodore Toethke
Loveliest of Trees, the Cherry Now, A.E. Housman

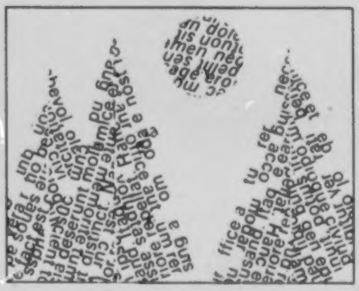
Exercise #4

There are two parts to this exercise. The first requires the students to go to their object and, after drawing a picture using a variety of natural materials, write a poem. The poem structure is included on the student activity sheet. The second part puts each student out on their poetic own. They will have compared their objective and subjective writing as well a heard amateur and professional writing. They are to go off by themselves, lean back against a tree or rock, and write!

Review: Complete the class by being available to help those that need help and then by directing all the students to work on their writing and develop it into a finished paper which will be evaluated a few days after this session. Give them plenty of time to work over their efforts. Be sure and send copies of the outstanding work to the Learning Center so that they may be considered for the Center's newsletter, **Openings.**

NOTE: Because of the limited space provided on the student worksheets, you may wish to have students use additional paper for these exercises. No space is allotted on the worksheet for completion of Exercise #4.

Creative Writing



Nature has always been a major source of inspiration for poets and painters. From the earliest recorded poets to the most recent, nature figures prominently as a source of ideas, allowing for a great variety of self expression.

In this activity you will learn, step by step, how to do creative writing. It is very important that you do not worry about penmanship or spelling. Be spontaneous. Write the first words that come to your mind. These words will, more often than not, be honest and straightforward expressions of your innermost feelings.

Following a creative writing briefing by your teacher, you will go into the forest and find an outdoor classroom. Near your outdoor classroom you will find a natural object that will become the subject of your writing activity.

Exercise #1
Write a physical description of your natural object for a person who is intensely curious about it, but has been blind since age four (so he will know colors). Deal with all physical characteristics and use all of your senses. What shapes? Colors? Textures? Tastes? Smells? When you complete this exercise, return to the outdoor classroom.

Exercise #2
Pretend the natural object is your mother or your father. Now, using descriptive words, prove that your natural object is like your parent. The shapes, colors, textures, smells, moods, feelings, etc., will remind you of characteristics of your parent. Show how these two things, your parent and the nature object, are similar.

Exercise #3
Look for characteristics and qualities that remind you of yourself. This may be something that you like very much about yourself, or possibly something that you do not like. Are you, like the object, a part of nature? Why or why not? Can you see your own lifestyle? Your temper? Your daydreaming?

Exercise #4
Draw a picture of your natural object. You may use pencil, crayon, charcoal, colors derived from rubbing leaves or grass on the paper, or any other material you wish. Try to capture the feeling you have for the object.

Write words about your natural object. On line 1 write two descriptive words that tell what it looks like. On line 2 write three action words that describe processes or changes taking place or things that are happening to the object. On line 3 write a four or five word phrase that tells how the object affects the rest of the environment or a phrase that describes any thought you have about the object. On line 4 write one word that sums up all you have written. When you have completed the four lines decide on one word that will serve as a title for your poem!

1 ____________ ____________

2 ____________ ____________ ____________

3 ____

4 ______________

Now that you have completed a structured poem, find a comfortable place, sit down and write! Write anything that comes to your mind. List ideas. List feelings that you have. If you don't seem to fit together, that is just great! You may, after you have written for a while, go to your teacher and discuss your writings.

Ecology Games

The thorough understanding of a concept is more likely when a student experiences the concept in more than one way. Games as learning tools can utilize the usual process of presenting information as well as (1) role playing, (2) hands-on activities, and (3) sensory experiences. With role playing, a student may be a judge or a wolf. Using hands-on activities students are normally asked to gather the information they will work with and with sensory activities the student will, ideally, be aware of the other feelings related to the subject, and thus better understand the concept.

This activity has three parts. The first is a reading which the students should do in the classroom. The length of time spent discussing the reading and its implications is up to the instructor, however, there is enough material for a lengthy discussion. The reading is followed by two games. One or both may be played. **Camouflage** is a hide and seek game and **Deer-Wolf** is a food chain game. Whenever a question on either game arises, the answer, if not readily apparent, can usually be found by looking to the same process in nature. For example, with deer-wolf tag the students will start with equal numbers of each and immediately all wolves starve to death. In nature, there are always more prey than predators in a given predator-prey relationship.

Deer-Wolf Game
Every winter many deer are killed and eaten by wolves, and every winter some of the weaker wolves and deer starve to death. The wolf and the deer, as well as the dozens of other birds, mammals and insects that enter into this particular predator-prey relationship all contribute to the balance of nature. Nature's "balance" does not mean that particular animal populations are constant. In the case of the deer and wolf, it simply means that there should never be a time when there are no wolves or no deer. In this game students will design a simple food chain playing deer-wolf tag. They will also learn the fundamentals of natural manipulation used to keep a system in "balance."

Camouflage Game
Many forest animals play "hide and seek" every day of their lives. For them it is a very serious game and often it will decide whether they live or die. Camouflage has a number of basic components including movement, color, location, visual patterns of the animal and visual patterns characteristic of the animal's habitat. In this game students will learn the characteristics of camouflage by incorporating them into a game of woodland hide and seek.

Instructional Sequence

Student Reading
Students should be directed to read and discuss the handout titled **Predator-Prey Relationships**. The facilitator should discuss the story and help the students to answer and understand the discussion definitions and questions. Tell the students that they will be asked to use terms included in the reading when they discuss the games.

CAMOUFLAGE GAME
In this game students will take turns at being either a predator or a prey. Upon completion they will better understand (1) the role of protective coloring in camouflage, (2) the use of the habitat as cover, and (3) a number of behavioral traits used by animals in the predator-prey relationship.

Step I

Divide the class into two equal size groups. One adult should work with the predators and one with the prey. Each group should be advised on how best to function. The predator and prey groups should be informed that animals normally are hardest to spot in the following situations:

a. Pressed flat against a tree.
b. Hunched down at the base of a tree.
c. Hiding under a wind thrown tree.
d. Hiding under overhanging branches.
e. Lying behind a downed log.
f. Hiding in the branches of a tree.
g. Standing still in a concealing background.

Step II

The **Prey** should be taken to a wooded area and told to hide. The instructor should hide also. **Predators**, after ten minutes, are led slowly around the area. A prey is captured when spotted. When captured, the predator and prey return to the back of the predator line and are done with the game. After one walk through, discuss successes, change roles and do the game again.

Discussion

Either in the field or in a classroom discuss the relationship of predator-prey situations to good camouflage.

Is behavior as important as color for camouflage? (Remember, most mammals are color blind!)

List examples of behavior which are beneficial for predator and prey.

DEER-WOLF GAME

In this game each student will take a turn at being a deer and a wolf. The objective is for the students to design a food chain that will result in both the deer and the wolf surviving, as is the case in nature. When the class is divided equally into deer and wolves, as it should be in order to emphasize the objective, the wolves will immediately "eat" all of the deer, and like the dinosaur, assure their own extinction. The students should then be prompted to determine a more stable ratio and try the game again. In this activity the students will (1) better understand the make up of a working food chain, (2) be involved in a process which demonstrates natural selection, and (3) be required to work as a team to acquire a goal.

Step I

Divide the group into "deer" and "wolves". The wolves must catch (2-handed tag) the deer. The rules for each group are as follows:

DEER Are safe in the thickets but can stay for just 60 seconds - the deer should count to 60. After 60 seconds they must leave, find something to eat (make a snowball in winter or pick up 2-3 rocks in the summer) and go to the other thicket. Deer cannot go into the thicket without food. If a deer stays in the thicket for more than 60 seconds it starves to death and when "eaten" it must go to the graveyard for a full 5 minutes and then emerge as a new fawn.

WOLF You must eat a deer every 3 minutes (count to 180) or you starve to death and spend 5 minutes in the graveyard to emerge as a new pup. Wolves cannot go within 10 meters of the thicket unless they are chasing a deer into the thicket. In other words, no guarding. Only the wolf that catches a deer gets credit for the kill, however, packs can hunt together. After each kill the wolf must start the count to 180 again and during that time catch another deer or starve. Wolves must "howl" so that the deer will know they are wolves.

Step II

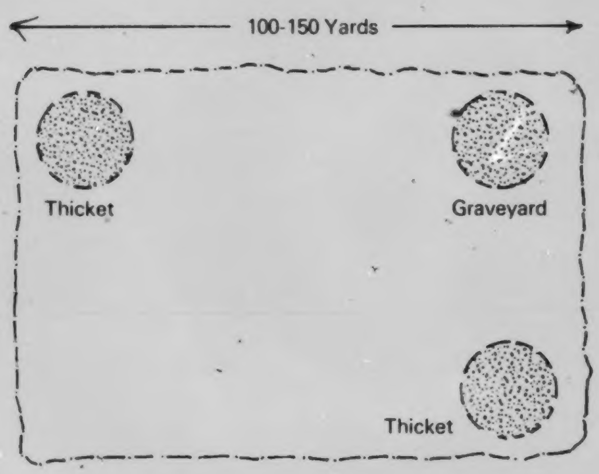
The deer should be allowed to go into a thicket and then the game starts. The borders of the playing field as well as the locations of the thickets and the graveyard should be defined.

Discussion

The following questions should lead students to a better understanding of how predators and prey help each other to survive:

1. Which deer were easiest to catch?
2. In nature, which real deer would be easiest to catch?
3. Would a wolf be more likely to eat sick, old and very young deer?
4. Which deer would be left to breed? Would they have healthy fawns?
5. Does it make sense to say that wolves actually do the deer herd a favor by making it healthier in the long run, if the system is balanced?
6. Would it be possible for this deer herd (students) to overeat its food supply?
7. Would the presence of wolves in an area help keep deer from eating their food faster than it could grow back?
8. What would happen if there were no wolves?

Deer-Wolf Game Playing Field



Predator-Prey Relationships

Hide and Seek in the Wilderness

A white snowshoe hare hides under a wind thrown spruce, its white fur blending perfectly with the surrounding snow and the protective cover of the spruce providing extra, and frequently unnecessary, camouflage. Running over the snow, a red squirrel is immediately visible, however, frozen motionless against the bark of a tall white pine, the same squirrel is invisible to all but the most observant. The white tail deer startles even the careful searcher when, all of a sudden, the twitch of an ear brings the animal into full and immediate focus.

Camouflage has many components, and usually all animals that depend upon camouflage for their well-being are masters of one component or another. The snowshoe hare actually changes color in order to increase its chances of winter survival. The deer doesn't change color as noticeably, but it is a master at standing dead-still in an area that seems to absorb the animal and make him just a part of the woods. When camouflage doesn't work, both the hare and the deer are capable of running away.

Wolves and Deer

The relationship of the white tail deer and the timber wolf is much more complex than might be expected. In real life, wolves eat many animals other than deer. During the fall wolves ambush beaver that are busy felling trees for their winter food supply. Wolves also eat snowshoe hare, birds, and small rodents. The wolf is an opportunistic feeder and will eat just about anything that it can catch without endangering itself.

Healthy deer have the best chances of escaping wolves but they, too, can be caught if easier prey is not available. Deep snow conditions are advantageous to wolves which have large paws that act like snowshoes. During times of heavy snow deer will yard-up and lay down a maze of packed trails to run on, permitting escape from the wolf. Often deer will select a yarding area that borders a wolf pack territory as the wolves seldom will leave the area they consider theirs, even if the possibility of a meal exists.

There is evidence to suggest that wolves do profoundly affect a low population of deer but that they have less effect when the deer population is high. In Northeastern Minnesota the deer population began declining in the late 1950's. This decline was due to natural habitat changes that followed intensive logging early in the 1900's. Natural succession has seen the logged areas slowly transformed from aspen into a climax forest of spruce and balsam which is not being logged as extensively as it was. In addition to this loss of habitat, unusually severe winters have resulted in both the winter loss of deer and a reduction in births the following spring. Fewer numbers of deer located in fewer "pocket" areas are easier prey for the wolf and thus the wolf plays an important role in keeping the population down. It is important to note that man, the two legged hunter, is much more effective than the wolf in killing deer, and that he, too, plays a major role in keeping the deer population of Northeastern Minnesota low.

In normal conditions wolves can help a deer herd in at least two ways. First, they "cull" the weaker deer. If the deer population is high, the wolf will likely be satisfied with first the old and then the very young. By taking the weaker deer the wolf assures that only the strongest deer will have offspring. Thus, with each generation the deer will be slightly more difficult to catch. To off-set this process, the wolf, too, will assure that future offspring are best equipped. This is accomplished by the fact that only the dominant male and female of each wolf pack will breed and have pups. A healthy population of deer and wolves will normally result in no damage to the overall population of either species nor their habitat.

An Intricate Balance

Predator-prey systems have an intricate balance. If too many prey are caught, the predators will starve. If to few prey are caught, the plant food supply may run out and the prey will starve. As predators catch prey, the only prey left will often be those that were most difficult to catch. They will normally be "better" parents and their offspring may also be more difficult to catch. The same works with the predator. An unsuccessful predator is most likely not going to live to have offspring and thus the predator also gets more effective. This is an example of animals adapting to their environment. When looked at over a long period of time these processes are called evolution. The elimination of predator and prey that are not successful is an example of natural selection.

Every winter many deer are killed and eaten by wolves and every winter some of the weaker wolves and deer starve to death. The wolf and the deer, as well as the dozens of other birds, mammals and insects that enter into this relationship, all contribute to the balance of nature. Nature's balance does not mean that particular animal populations are constant. In the case of the deer and the wolf, it simply means that there should never be a time when there are no dear and no wolves.

Discussion

Wind Thrown is the term used by foresters to describe a tree that has been blown over and is lying on the ground.

Opportunistic Feeders are animals that will eat whatever they can whenever they are hungry. Most predators are opportunistic feeders. Name other predators that are opportunistic.

Predator-Prey is used to indicate the relationship between certain animals with the predator the hunter and the prey the hunted. Name and describe animals that are both predator and prey. Name and describe animals that are only prey.

Deer Yard is the term used to identify an area where deer have congregated. There is usually an adequate supply of food and escape routes.

Territory, for the wolf, is a feeding territory. White tail bucks define their mating territories as do most perching birds. Waterfowl have nesting territories. Name other animals that have territories. How do they defend their territories?

Succession describes the way a forest community will evolve or change. In Northeastern Minnesota the forest will change until it becomes a climax forest. Without fire or logging it will stay a climax forest. Why will the forest stay climax?

Habitat is the natural area in which a species of animal or plant is found. The habitat may be likened to the "address" of the species. An area within the Superior National Forest may be excellent habitat for the white tail deer and another may be very poor. Why should this be?

Dominant is the term used to define the "leader" of the group. In any wolf pack, one male and one female are dominant. Give other examples of dominance in the animal kingdom.

Species has been defined as a group of organisms that can interbreed and produce fertile offspring. Are red squirrels and gray squirrels of the same species?

Balance of Nature is very complex. List factors that contribute to the balance of nature and then write a definition for balance of nature.

Evolution is the constant, on-going change of all living things to fit into their environment. Evolution may be a series of adaptations.

Adaptation is well demonstrated by the elephant's trunk, the giraffe's neck and the hummingbird's ability to hover. Why are these adaptations? Name special ways other animals have adapted to their environment.

Natural Selection is the process in nature whereby the healthy survive. On a long-term basis a species that would not adapt to its environment is likely to become extinct due to natural selection. Were the mastodons victims of natural selection?

Food Chain is the transfer of energy from one living thing to another. For example, plants are eaten by mice which are eaten by weasels, which are eaten by owls. The plant's energy, from the sun, is used by the mouse, the weasel and the owl. Is man part of a food chain?

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Forest Communities and Bird Identification

The major objective of this activity is to provide students with an ecological approach to bird identification. Several major forest communities are identified as are the birds that are most likely to be found in each.

Birds spend varying lengths of time in Northeastern Minnesota. In March the birds that came from the north and wintered in this area begin leaving. They are primarily predatory owls. When the snow melts the first wave of migrants returns from the south. These are primarily the seed-eaters that wintered in the tropics and sub-tropics, waterfowl, blackbirds and hawks. In late May the insect-eating birds return. Although there is a trickle of insect-eating species returning to the area throughout the month, most do not return until late May when the food supply is more certain. Starting in mid-August the majority of insect-eaters begin their journey south.

Fourteen forest communities have been identified for the Superior National Forest. Some species of birds will find their needs in several of the different communities but many will be satisfied in only one.

In this activity students will (1) be introduced to the concept of a forest community and a community profile, (2) relate bird species to specific forest communities, (3) learn to use a parabolic receiver and recorder to obtain bird songs, (4) learn to use binoculars and bird identification books. The equipment needed to conduct this activity is provided.

Instructional Sequence

Part I Identifying Forest Communities

Identifying forest communities consists of a reading which describes the vegetative and bird-life characteristic of five forest communities. Have the students read each part and review the names of the communities and the tree types.

Part 2 Bird Identification

Bird identification is best done with binoculars, a bird book and an experienced birder. An ELC Naturalist, on tape, will serve as the experienced birder. Using the bird book and the tape, have the students page through the book as the Naturalist discusses the individual species. This activity will help the students become more familiar with use of the book and bird identification.

The tape contains a brief comment on each of the following birds as well as a reproduction of their calls. The page number indicates the location of each species in the Field Guide.

Blue jay	P 208
Pileated woodpecker	P 180
Hairy woodpecker	P 186
Downy woodpecker	P 186
Raven	P 212
Evening grosbeak	P 292
Great horned owl	P 160
Broad-winged hawk	P 72
Killdeer	P 112
Common flicker	P 180
Least flycatcher	P 198
Eastern Kingbird	P 192
Red-winged blackbird	P 280
White-throated sparrow	P 320
Ruby-crowned kinglet	P 236
Chestnut-sided warbler	P 266
Chipping sparrow	P 318
Red-eyed vireo	P 248
Oven bird	P 270
Ruffed grouse	P 84

Part 3 Forest Communities and Bird Identification Data

Take the class to Community #1 which is located behind the gymnasium. This community, like the rest, is identified by a large routed wooden sign. (You may want to ask the students if the design on the sign can be related to the activity.) This area is a good example of a mixed deciduous-coniferous community. Point out the types of trees and cover that occur. Call attention to the vegetative layers. Walk along the southern edge of the area and you will, most likely, find a white-throated sparrow. Identify the bird using the book and attempt to record its song. Each team should have a clipboard and a copy of the data sheet upon which to record their observations. Direct the teams to the following communities and repeat the observations made at Community #1.

Community #1 Mixed Deciduous - Coniferous
Located east of the Center gymnasium

Community #2 Open Disturbed
Located ½ mile east of the Center - a recent clear and selective logging site.

Community #3 Pine Community
Located north of the Center waste treatment facility. These are virgin jack pines.

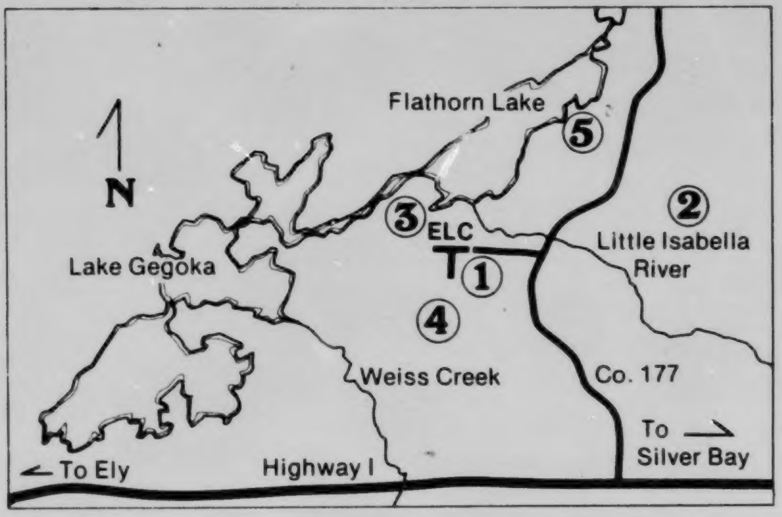
Community #4 Black Spruce-Tamarack
Located south of the Center. This is a fragile bog, tell the students to be careful.

Community #5 Mature Deciduous
Located on the east side of Flathorn Lake immediately past the burn area while traveling north. Usually has plieated woodpeckers.

Ask the teams to return at a pre-determined time. The instructor should visit each community and aid teams if help is needed. Upon return have each team report on their findings and play the bird calls that were recorded.

Sources
Birds of the Superior National Forest

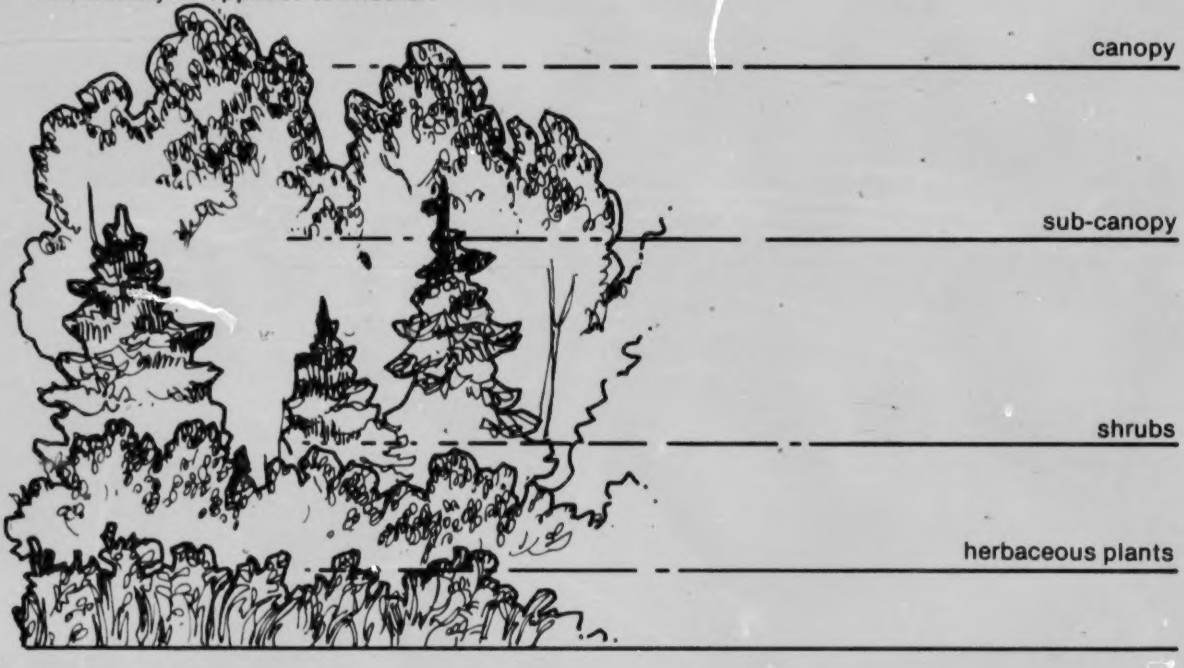
Forest Community Locations



Forest Communities and Bird Identification

The easiest way to learn about birds is to start with local species. This is true if you are at home or on a vacation. Individual species live in places that satisfy their needs. It is possible to predict the kinds of birds that will be living in an area by recognizing the area. Ornithologists, people who study birds, call the specific areas "communities". A forest community is a complicated system with many interactions among plants, animals, climate and soil.

A Forest Community Profile
The following diagram shows a forest community and its layers. It is possible to predict the type of vegetation within each of the communities. Bird species frequently prefer to live in one forest community as opposed to another.



Part 1 Identifying Forest Communities

The Pine Community A mature pine community is generally composed of large red, white, or jack pine up to 100 feet tall. The sub-canopy is sparse and usually consists of birch, balsam fir, or spruce. Shrubs are usually sparsely developed due to the lack of sunlight and include hazel and mountain maple. Ground cover is sparse with bunchberry, wintergreen and pine needles present. Lichens and mosses are common. Birds that are common include the red-breasted nuthatch, brown creeper, hermit thrush, ruby-crowned kinglet, golden-crowned kinglet, yellow-rumped warbler, ovenbird and chipping sparrow.

Mature Deciduous Community Quaking aspen, bigtooth aspen, balsam poplar, paper birch and maple are common in the mature deciduous community. The sub-canopy is usually well developed with saplings of the canopy trees; spruce, hazel, Juneberry and mountain maple may compose the shrub layer. Common birds include the yellow-bellied sapsucker, least flycatcher, black-capped chickadee, veery, red-eyed vireo, ovenbird, black and white warbler and the pileated woodpecker.

Black Spruce - Tamarack Community This community is usually in lowland areas and is dominated by black spruce and tamarack with an occasional balsam fir or jack pine. High shrubs are thin willow and alder and the low area is usually Labrador tea. Primary bird species include the Connecticut warbler, yellow-bellied flycatcher, hermit thrush, golden-crowned kinglet, yellow-rumped warbler and Cape May warbler.

Mixed Deciduous - Coniferous Community This community is most common in Northeastern Minnesota. Tree species are variable. Ground layer consists of wild sasparilla, large leaf aster and bunchberry. Typical birds include the ruffed grouse, black-capped chickadee, veery, white-throated sparrow, purple finch and broad-winged hawk.

Open Disturbed Community This community is usually the result of forest fire or logging. If the area has been clear cut there will be fewer birds than if the area is a selective cut. The main vegetative feature of this community is the shrub layer or patches of plants. Raspberry picking is always good in the disturbed areas. Birds normally sighted include the red-tailed hawk, American kestral, common flicker, eastern kingbird, tree swallow, American robin, chestnut-sided warbler and the white-throated sparrow.

Part 2 Bird Identification

Understanding that birds have preferred areas will help reduce the number of identification options for bird watchers. Owls prefer to nest in mature pine stands. Woodpeckers like mature deciduous trees. Knowing where to look is very important. Recognizing distinctive markings is also very necessary.

Distinctive Markings

Size and Shape

Estimating size is the first step in identification. Compare the bird to be identified to a known bird. For example, all warblers are closer in size to a sparrow than a robin.

Bills

The shape and length of a bird's bill will frequently help with identification. Insect eaters have sharp bills. Seed eaters have thick stubby bills.

Field Marks

Birds with **crests** are easily recognized. **Face patterns** are most helpful in identifying warblers. The ruby-crowned kinglet has a ruby **crown**. The common flicker has a white **rump patch**, and the myrtle warbler is also called the yellow-rumped warbler for a good reason. Wing-bars, eye-lines, and breast-spots also help with identification.

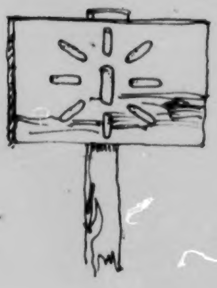
Bird Calls

Bird songs are valuable aids in identification. Many seasoned birders can identify the majority of birds by the song. Prior to leaving for the forest, an ELC Naturalist will comment on a variety of birds and do an imitation of each bird song. Follow along in the bird book and then see if you can find and identify some of the birds on the field trip.

Field Trip

The instructor will help students complete the data sheet for one of the forest communities, and then teams of students will go each to a different community and record their findings.

Part 3 Forest Communities and Bird Identification Data



There are five different forest communities located near the ELC. Each is identified with a sign like the one pictured here and each is numbered. Using the community descriptions included in Part 1, go to one of the areas and determine what type of community it is. Identify as many birds as you can within the community, indicating the identifying marks and whenever possible recording its song.

If your team has time you may do a second community.

Community #1 mixed deciduous-coniferous

Birds Sighted	Identifying Marks

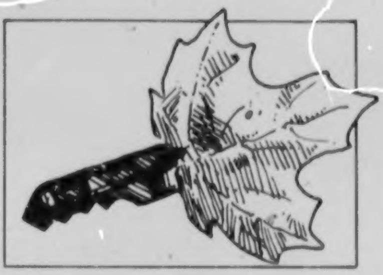
Community #

Birds Sighted	Identifying Marks

Community #

Birds Sighted	Identifying Marks

The Great Key Race



The Great Key Race is an activity that introduces students to the use of identification keys. The activity culminates with a race in which teams of students go into a specified forest area and "key-out" a number of different tree and shrub species. The first team to correctly identify a specified number of species wins the race. By completing this activity, students will (1) understand the need for keys, (2) learn how to use a key, (3) learn how to make a key, (4) use a key as part of the race, and (5) learn to recognize a number of common trees and shrubs.

In this activity students will use trees and shrubs to learn about keys. Plants, the basis of all life on earth, are the only living things able to synthesize food. Plants replenish the air with oxygen and they have countless uses for medicine, lumber and other important products that affect our lives. Plant identification is most accurately done with the use of a key.

The Learning Center is located in a boreal forest biome which extends from the North Shore of Lake Superior to the treeline of Canada. There are about 126 tree and shrub species in Northern Minnesota, but only 20 are common enough to find easily. Willows can be divided into 14 distinct species and it is common for them to hybridize between each other, so there are always problems separating them. Deciduous trees, those that lose their leaves in the fall, are frequently compared to evergreens. Coniferous trees are cone bearing, and while most are evergreens, the tamarack is a coniferous deciduous tree.

Instructional Sequence

There are four parts to this activity. The first three introduce students to the use of keys. The fourth is a race in which the students are required to identify a number of trees and bring the correct identification back to the instructor. While tamarack, black spruce and balsam poplar do grow in the area, they are not to be found in the tree identification area. There are 17 different species marked in the identification area and the number to be identified cannot exceed that number. It is recommended that a minimum of 5 be identified.

Part I
KEYING OUT PETS is a very simple exercise which demonstrates the step-by-step process used in keys. Remind the students to read both options for each number before looking into the right hand column for an answer or directions.

Part II
The CONVERSATION KEY which follows is just a bit more difficult. Tell the students to read the instructions very carefully and only then should they go ahead and see if they can fill in the blanks to the key. It is extremely important, with this exercise and with all keys, to do each step in the required order.

Part III
The FRIEND KEY has 2 parts. The first uses 6 stick figure people drawn on the student activity sheet. Divide the class into teams of three or four and instruct them to key out the "stick friends". The key is started and because the differences are few the key should be done quickly. Next, have six real friends stand in front of the class and ask the teams to key them out. This is the last indoor

activity before the race, and the instructor should check each group to see that they are using the proper procedures.

Part IV

Again using the 3-4 member teams, tell the students that they will go outside and, as a class with the instructor providing the leadership, key out an evergreen and a deciduous tree. Prior to going outside, give each team a tree key for the season, a hand lens or two, and a clip board. After keying out the two trees, place the students at a starting line, and tell them that the first team to identify a number (5 or more) of trees in the identification area and return with the correct identification to the starting point, is the winner of the "Great Key Race". Trees within the identification area are numbered as follows, and the teams should bring you the tree number with the name of the species:

#	Species
1	White Pine
2	Red Pine
3	Jack Pine
4	White Spruce
5	Mountain Ash
6	Quaking Aspen
7	Balsam Fir
8	White Cedar
9	American Elm
10	Mountain Maple
11	Alder
12	Red Osier Dogwood
13	Pincherry
14	Beaked Hazel
15	Willow
16	Black Ash
17	Paper Birch
18	Tamarack
19	Black Spruce
20	Balsam Poplar

The Great Key Race
Student Worksheet

Keying Out Pets

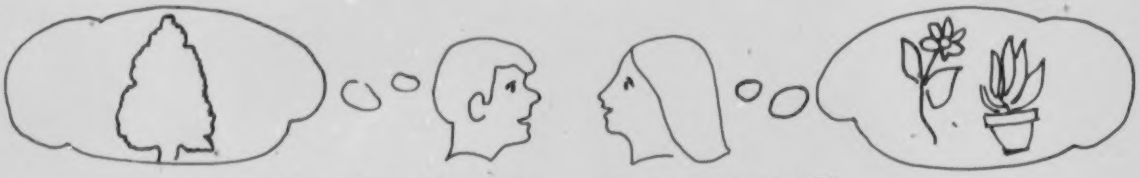
Pick out the pet you would most like to have and see how quickly you can key it out. Remember, if the instructions tell you to go to 2, you must look at both of the descriptions at 2 and only then look for the next step or the answer. When you have completed the key, raise your hand!

If this is true. . . .		Do this
1	Has fur	2 (go to 2)
1a	Does not have fur	4
2	Barks	3
2a	Meows	Tiger
3	Curly haired	Poodle
3a	Straight haired	Retriever
4	Feather	Bird
4a	Has no feathers	5
5	Has armor-like back	Alligator
5a	Has gills	Shark

The Conversation Key

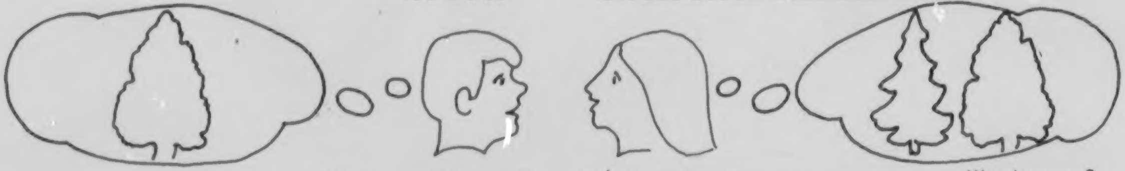
The following "conversation" is really a verbal plant key. By asking questions it is possible to reduce the number of options until only the right answer is left. Read the definitions carefully and use some of the words identified to fill in the key blanks.

Evergreen is a tree that does not shed its leaves.
Deciduous is a tree that does shed its leaves.
Conifer is a tree that has cones. Most evergreens are coniferous.
Cedar is an evergreen that has scale-like leaves. Most evergreens have needle-like leaves.
Balsam is an evergreen that has needle-like leaves.



"I have a plant in mind." "Oh, what kind is it?"

"It's a tree." "Is it deciduous or___________?"

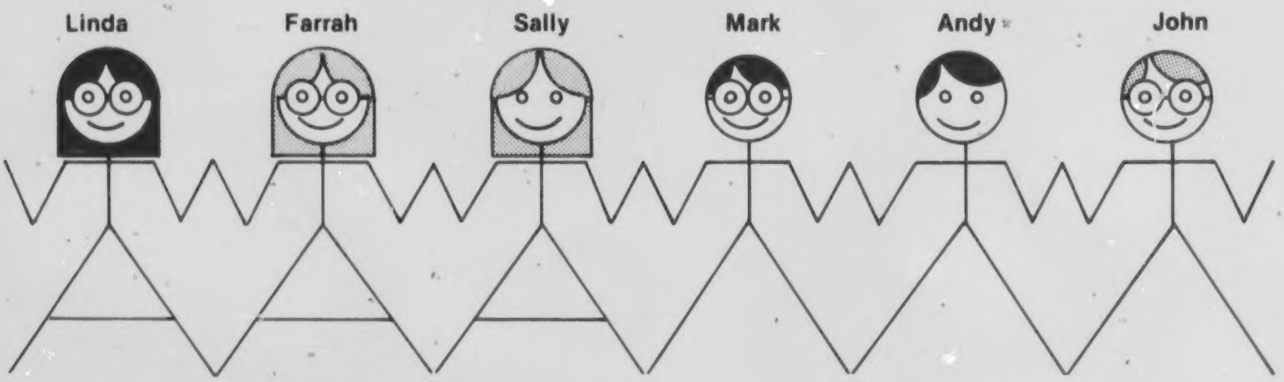


"It's an evergreen." "Needle-like leaves or_________-like leaves?

"__________-like leaves." "It's a cedar tree!"

A Friend Key

There are two parts to this key. First, your team of students should make a key for the six "stick friends" below. The key is started for you and the differences you should look for are male and female, light hair and dark hair and glasses. When you have completed this key, it will be checked and your team will be asked to key out six real friends. With the real friends you should look for the same kind of differences plus, if necessary, others.



Stick Friends

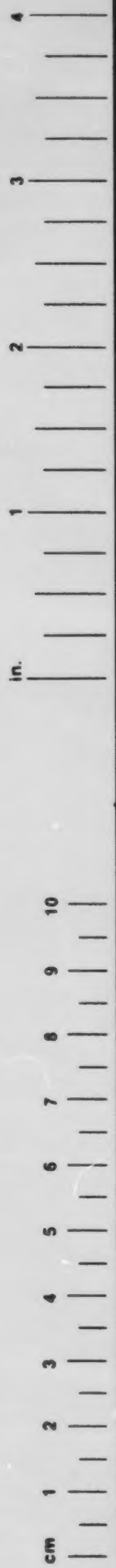
	Column "A"	Column "B"
1a	Boys	2
1b	Girls	3
2a	Glasses	4
2b	NO Glasses	Andy
3a		
3b		
4a		
4b		
5a		
5b		
6a		
6b		
7a		
7b		

Real Friends

	Column "A"	Column "B"
1a		
1b		
2a		
2b		
3a		
3b		
4a		
4b		
5a		
5b		
6a		
6b		
7a		
7b		

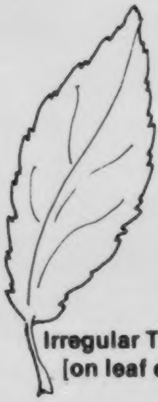
Key to Common WINTER Trees and Shrubs

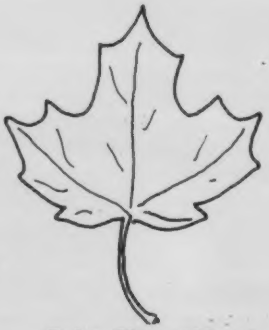
1	Plant with needle or scale-like leaves	2
1a	Plant without leaves in winter	8
2	Leaves scale-like	White Cedar
2a	Leaves not scale-like	3
3	Needles flat, 2 white lines beneath, smooth blistery bark	Balsam Fir
3a	Needles, not flat	4
4	Needles short (less than 3 cm), square in cross section	5
4a	Needles longer than 3 cm	6
5	Needles short, 1-1.5 cm, brown hairs on twigs, in wet areas	Black Spruce
5a	Needles 1.5-2.5 cm, in dry areas	White Spruce
6	Needles in bunches of 5, dark gray bark	White Pine
6a	Needles in groups of 2	7
7	Needles 3-5 cm, scaly bark	Jack Pine
7a	Needles 6-14 cm, reddish bark	Red Pine
8	Plant with prominent knobs on small twigs in bogs	Tamarack
8a	Plant without prominent knobs on small twigs	9
9	Buds larger than 8 mm	10
9a	Buds smaller than 8 mm	13
10	Buds covered with white hairs	Mountain Ash
10a	Buds without hairs	11
11	Buds longer than 12 mm covered with sticky resin	Balsam Poplar
11a	Buds shorter than 12 mm	12
12	Buds on long, rough projections; bark white and peeling on older trees	Paper Birch
12a	Buds not on projections, tips firm, greenish-gray bark	Trembling Aspen
13	Shrub with reddish bark	14
13a	Tree or shrub without reddish bark	16
14	Bark with long horizontal raised markings (lenticels)	Pin Cherry
14a	Bark with round lenticels	15
15	Entire stem red	Red-Osier Dogwood
15a	Bottom half of stems gray or tan, upper red	Mountain Maple
16	Bark smooth gray with horizontal white spots, near water	Speckled Alder
16a	Bark not gray with horizontal white spots	17
17	Twigs light brown with vertical white spots	Beaked Hazel
17a	Twigs without vertical white spots	18
18	Bark with alternating thin red and white layer, branches arch up and out	American Elm
18a	Bark without red and white layer	19
19	Bark shallowly flaky, cross hatched, rectangular, tree near water	Black Ash
19a	Buds covered by single scale	Willow

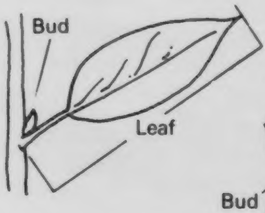


Key to Common SUMMER Trees and Shrubs

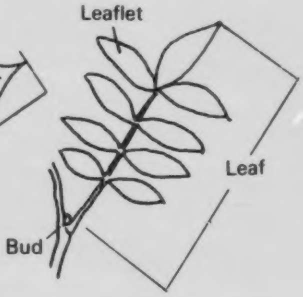
1	Broad, flat leaf	2
1a	Needle or scale-like leaf	13
2	Tree (trunk larger than 3 cm diameter)	3
2a	Shrub (trunk less than 3 cm diameter)	9
3	Compound leaf (with leaflets)	4
3a	Simple leaf	5
4	More than 7 leaflets, smooth brown bark	Mountain Ash
4a	7 or fewer leaflets, in wet areas	Black Ash
5	White or gray-green bark	6
5a	Bark not white or light gray-green	8
6	Bark white and peeling	Paper Birch
6a	Bark light gray or green	7
7	Leaf round, flutters in slight breeze	Quaking Aspen
7a	Leaf oval, buds sticky, fragrant	Balsam Poplar
8	Branches arched gracefully up and out, oval leaf with single size teeth	American Elm
8a	Small tree, near water, gray trunk with raised horizontal white spots	Speckled Alder
9	With reddish twigs	10
9a	With brown or yellow twigs	12
10	Leaves palm-shaped, lower stems brown	Mountain Maple
10a	Leaves oval	11
11	Leaf-veins turn inward toward midline, no teeth	Red-Osier Dogwood
11a	Leaves thinly oval, shiny, tiny teeth	Pin Cherry
12	Thin yellowish twigs, long skinny leaves	Willow
12a	Leaves irregularly toothed, bark tan	Beaked Hazel
13	Leaves scale-like	White Cedar
13a	Leaves needle-like	14
14	Needles in groups joined at base	15
14a	Needles single	18
15	Needles in bunches of 2	16
15a	Needles in bunches of more than 2	17
16	Needles 2-6 cm, cones curved	Jack Pine
16a	Needles longer than 8 cm	Red Pine
17	Needles usually in bunches of 5	White Pine
17a	Needles in tufts of more than 5, in bogs	Tamarack
18	Needles flat, smooth bark with resin blisters	Balsam Fir
18a	Needles diamond shaped, less than 2 cm long	19
19	Needles 1-1.5 cm, brown hairs on twigs, in bogs	Black Spruce
19a	Needles 1.5-2.5 cm, twigs hairless, in dry areas	White Spruce


Irregular Teeth [on leaf edge]


Palm-Shaped Leaf



Simple Leaf



Compound Leaf

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Winter Birding

Can you imagine a person driving from California to Northern Minnesota in hope of seeing a spruce grouse? If you are a serious birder, you can. Birding is a rewarding and popular hobby. In the spring serious birders can identify as many as eighty different species of birds without driving anyplace. A walk in Minnesota's Northwoods is all that is required. Birding in the winter is not so productive due to the number of birds that prefer to spend the winter in the south. Winter is a time of reckoning. High winds, deep snows and sub-zero temperatures make humans want to be on the inside of a window looking out. Yet, even on a -20 day, a peek at the bird feeder will often reveal tiny chickadees and nuthatches flitting from branch to feeder with unusual quickness.

This activity is very teacher directed. The student reading is brief and the data collection form requires explanation to be properly used. The information in the instruction guide that follows contains many concepts and definitions which the student may be asked to record and recall.

When this activity is completed, students will (1) understand that migration is an adaptation, (2) be able to give examples of other adaptations, some quite unique and unusual, (3) learn to use a field guide and binoculars, (4) have the opportunity to start their own bird list consisting of up to 14 winter species, and (5) record various data about birds, their habitats and their adaptations.

Instructional Sequence

This activity will take about 3 hours with one hour or less needed indoors. After the students have read the student reading, the concepts should be reinforced using the material that follows.

Migration

Migration is extremely complex. Whales migrate for breeding purposes. Robins and geese go south for food. Lemmings migrate when their conditions become crowded. African elephants will migrate during times of drought. It has been suggested that birds once inhabited just the equatorial regions and, due to overcrowding, they began going north during those times when food was available and thus began the evolution of an adaptation called migration.

Where and when animals go is an observable fact, but just why and how is in many cases still a mystery. ESP, telepathy and other psychic powers may have their foundation in some unexplained sensory system used by animals when migrating. The hummingbird will, just prior to preparing for migration, store up fat until its body is almost 50% fat. During the 500 mile nonstop flight, they will use just 1½ grams of this fat as fuel to provide the needed energy. The salmon will return to the exact spot that it was hatched, so that it may spawn and then die. Natural selection will eliminate those salmon whose built-in guidance system fails them, thus fine tuning this inherited sensitivity. Deer mice have been moved 2 miles from their home range and in less than 48 hours have been back to the exact spot where they were first captured. Another classic example of the migration mystery is the Atlantic eel. Those from the Western Atlantic and those from the Eastern Atlantic leave at different times to arrive at the Sargasso Sea at the same time! There, both varieties breed and start their journey back to the rivers on their respective sides of the ocean. It should be noted that they look different because they have such different habitats and for a long time scientists thought they were different species. The sapsucker will leave Northeastern Minnesota each winter, just as sure as the arctic tern will fly from one end of the earth to the other. Why and when can usually be figured out, but in most cases, how is still a mystery.

Adaptation

Adaptation can be defined as any characteristic or form of behavior that aids an animal's survival. Migration is an adaptation. When the robins flock up and fly south they demonstrate an adaptation of behavior. The ruffed grouse grows hairlike "snowshoes" each winter to permit easier movement over the snow. These snowshoes are an adaptation of form. Desert plants adapt to dry conditions. Many have thick skins that conserve moisture and most will not flower unless there is the right amount of moisture. There is a tendency to speak of "forbidding" cold or heat and to talk of plants and animals being able to withstand extreme conditions. In fact, adaptation means that the particular organism is living under conditions for which it is well suited. For example, a thick layer of fat underlies a penguin's feathers. The layer conserves heat and also serves as a cooling system when the animal gets too hot. At zoos penguins are often seen cooling themselves off by a rippling motion of their feathers. Penguins are not comfortable at temperatures that seem pleasant to human beings.

The finches of the Galapagos Archipelago, as observed by Darwin, provide the classic example of adaptation. Within each habitat, the niches (opportunities for making a living) were filled with different finches. The birds were different. Some had short seed cracking beaks, others had long bills, and they all started as the same animal!

The birds that will most likely be observed include the ruffed grouse, which adapts to winter by growing snowshoes to permit easier travel. Juncos and snow buntings, while seen in the early winter, will have migrated by the time of deep snows and cold of January. Black-capped chickadees and nuthatches are tiny birds whose bodies, because of size, do not produce great quantities of heat (energy). To offset this condition, both are very active. They also eat more often than the larger birds. The gray Canada jay best demonstrates the technique most winter birds have for conserving heat by use of effective insulation. The jay looks very fluffy as it sits quietly in the cold conserving the heat generated by its body.

Field Trip Guide

Each student should have a clipboard, the activity sheet and binoculars. Each pair of students should have a **Field Guide to Birds**. Two areas should be visited with one half of the class spending about an hour at each and then changing. Tell the students to observe and record as many birds as they can at each site.

Site One: Feeders

There are a number of bird feeders located throughout the area. The feeder groups may be divided into smaller teams. The key is staying still and quiet.

Site Two: Trails

Hiking along any trail away from buildings will usually produce woodland birds. Woodpeckers are best sighted near mature trees and grouse are most often seen in areas of heavy brush.

The birds that will likely be seen, from the largest to the smallest, are:

ruffed grouse
common raven
pileated woodpecker
gray jay
bluejay
evening grosbeak
pine grosbeak
black-backed woodpecker
hairy woodpecker
downy woodpecker
red-breasted nuthatch
black-capped chickadee
boreal chickadee
redpoll

Species should indicate the name of the bird.

Number Seen should indicate the number of different individuals sighted.

Page is for the number of the page in the bird book for the species.

Nearest Food should indicate what the bird was observed eating.

Distinctive Marking should indicate the one most noticeable characteristic.

Size should be 1 if larger than a crow, 2 if larger than a robin and smaller than a crow and 3 should be smaller than a robin.

Movements should indicate the number of times the bird moves in a ten second span of time. There will be a relationship to movement and size as the small birds must eat more and more to keep warm.

This activity should be culminated with a review of the objectives listed in the introduction.

Winter Birds

Adaptation
An **adaptation** is any characteristic of form or behavior that aids an animal's survival. When the robins fly south and leave the winter snow and cold behind they demonstrate an adaptation in behavior. The ruffed grouse grows hairlike "snowshoes" on its feet during the winter to make movement over the snow easier. The snowshoe-like feet are an adaptation of form.

Migration
The **migration** of birds and other animals contains many unsolved mysteries. Reasons for migration include (1) mass movements for purposes of feeding, (2) movements for the purpose of breeding, (3) movements to prevent overcrowding, and (4) a movement that is needed as response to change in environment. Can you think of an example of an animal that migrates for each of these four reasons?

For birds of Northeastern Minnesota the shortening of the day seems to trigger the changes that result in the southward migration. The great mystery of migration is not why birds migrate, but how. Young birds often leave before their parents, and yet they know exactly where to go. Birds migrate on dark cloudy nights and go exactly in the right direction. Experiments have shown that some birds can sense the earth's magnetic field, and therefore are a compass. Homing pigeons cannot find their way home if a small magnet is attached to the. While birds always seen to go in the right direction, they will often have problems on very foggy nights when they have been known to develop vertigo and fly upside down! Geese often fly low over cities when they mistake the reflection of the city lights for the reflection of stars on a body of water. One migration fact is clear. Birds migrate accurately and often they will land on exactly the same branch of the same tree year after year.

Adapting to Winter
Birds which winter in the north must deal with cold and snow. Most have developed special qualities (adaptations) which enable them to be comfortable and successful. Smaller birds cool off quicker and so they are generally more active than the larger birds. Most winter birds have effective insulation. Gray jays look very fluffy. Their downy feathers trap insulating air around their bodies and, because of their size and insulation, the jays are less active than nuthatches, which are much smaller.

Food is harder to find in the winter. When the feeders are empty (or not provided) the chickadees and nuthatches eat insects in bark furrows. Redpolls hang upside down and eat alder seeds. Jays and ravens are scavengers that clean up after wolves and other predators. Grouse eat buds from aspen trees and grosbeaks eat seeds wherever they can find them. The grosbeak has a beak that is specially adpated to opening hard shelled seeds. Woodpeckers dig for insects in tree trunks and their special beak is another example of an adaptation.

Discussion
Define an "adaptation of form". Give at least one example.
Define an "adaptation of behavior". Give at least one example.
Define "migration" and give an example of the four types.

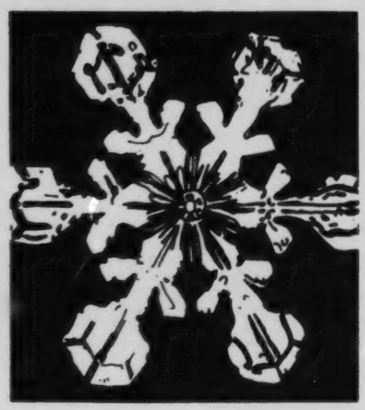
Data Sheet for Winter Birds

Species is the name. **Number seen** is the number of individuals you sighted of each species. **Page** is the page in the field guide, and **nearest food** should indicate where the birds obtained most of their food. Enter the most distinctive marking. A #1 bird is larger than a raven, #2 is smaller than a raven but larger than a robin, and #3 is smaller than a robin. Try to determine how many times each species moves within a ten second time span. Which size birds move most?

You may find 14 different species. Those who spot ten or more are on their way to becoming expert birders!

Species	No. Seen	Page	Nearest Food	Marks	Size	Movement

Snow



Snow has texture, shape and chemical composition. It has uses in insulation, transportation, construction and, most importantly, life. Snow can make transportation impossible, bury items until spring, and be responsible for death. It enables skiing and snowshoeing, gives us track stories and insulates and protects countless living plants and animals. Snow is the most apparent indicator of winter in the Northwoods.

In this activity students will learn about snow. They will (1) examine the pH of snow and learn how pH relates to environmental concerns, (2) determine the water content of snow in a variety of situations, (3) measure temperatures and relate temperature to compaction, and (4) examine the effect of wind and human activity on snow as demonstrated by a snow profile.

Divided into teams, the students will do four tests at each of four different locations. The tests are (1) pH, (2) temperatures, (3) profile and (4) water content. The locations are the field, a snowbank (man made) and someplace in the woods. The fourth location should be one that the students select. The reason for selecting the fourth site should be an anticipated unusual result in any one of the tests.

Note: Snow pH could produce startling results. The instructor may wish to not tell the students that the snow will be acidic. The reason, as indicated in the instructor's information that follows, is that upper air movements carry sulfur dioxide from the coal burning industries located on the lower Great Lakes. The sulfur dioxide is carried over our area, combines with precipitation and falls as acid rain or snow.

Instructional Sequence

Each three-person team should receive a set of materials consisting of a meter stick, a snow shovel, a clipboard, a probe-type thermometer, a pH kit, a snow-water-content-collector and a copy of the student activity sheet.

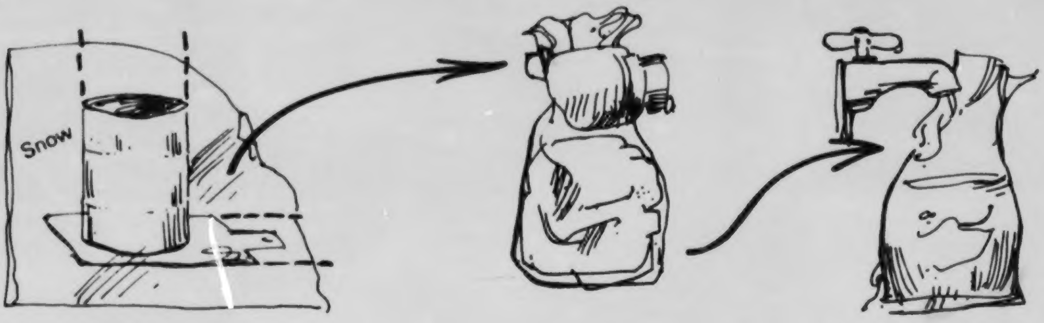
Step 1
Divide the class into three-person teams and pass out the equipment needed.

Step 2
The students are to read the activity sheet. A discussion should follow to assure that the meaning of insulation, profile, pH, compaction, acid snow, firn and depth hoare are understood. The student reading plus the instructor's information that follows will provide necessary information.

Step 3
Instruct the teams to use the recording sheet and obtain the data required. When completed the teams should return to the classroom, melt the snow and complete pH and water content entries. The outside portion of this activity will take at least 60 minutes.

Test One: Water Content
Water content will be determined by taking a core of snow with the open ended cans provided. The core should be placed into a plastic bag and labeled for each of the four sites. The core will be taken

back to the classroom where the bag will be placed under hot water to melt the snow. The volume of water for each core should be measured with the amount entered on the student data sheet.



The water that is needed for the pH test will be the same water that results from the content test. It is important not to lose any of the collected snow or meltwater.

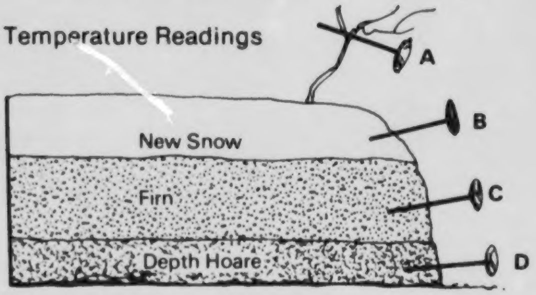
Test Two: Snow Profile

Using the shovel provided, students should dig a "trench" in the snow to be profiled. The line between new snow and firn is frequently difficult to determine, however, the student usually can guess within an inch. The top of the depth hoare and the bottom of the firn is usually visible, however, the texture difference is always apparent by touch. Students can scrape away the firn with the shovel and when they reach the depth hoare the texture change will become apparent when the scraping produces a different sound. The students should draw a picture of each profile and measure the depth of each layer.

Test Three: Temperatures

The thermometer should be inserted into each of the levels of snow and the temperature recorded. The thermometer must stay in for 2 minutes in order to produce an accurate reading.

Temperature Readings



"A"	A recorded distance above the snow
"B"	In the new snow
"C"	In the firn
"D"	In the depth hoare

Test Four: pH

For this test it is necessary to understand that pH is a measurement of snow quality. The student reading explains the variables and indicates that a healthy pH is in the neighborhood of 7 on a scale from 1 to 14. Snow pH in this area has been as low as 4.5 which is much more acidic than most people would ever expect. The air pollutants that result in this "acid snow" are likely from the industrial regions around the lower Great Lakes and carried here by air movements in the upper atmosphere. The acidity of precipitation so far from the pollution source should be emphasized. Pollution is a problem and eventually all types of pollution can have a negative effect on the quality of life. For most, acid snow in the Northwoods is a shock and will result in greater interest. After discussing pH as presented above and in the student reading, examine the kit and see that each team understands its use. Each kit contains use instructions.

Summary

When all of the data is collected, ask each group to report on the differences they discovered among the sites examined. Ask the students how the differences affect small mammals, people and the future.

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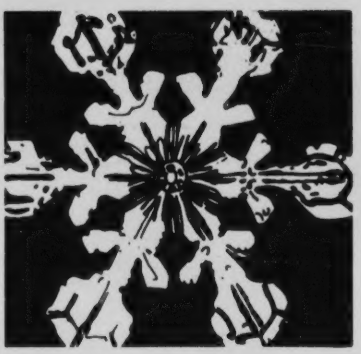
Snow



Snowflakes
The basic structure of a snowflake consists of one molecule of oxygen and two of hydrogen. One single snowflake can have over 100 million of these molecules and one cubic foot of snow, about one shovel full, has over 600,000 snowflakes!

To start growing, a snowflake needs a nucleus. This nucleus may be dust from a farmer's field in southern Minnesota or a volcanic eruption. It might also be a microorganism (small plant or animal) or sulfur dioxide from a coal burning steel mill in Gary, Indiana. The form of the flake depends on many things, however the temperature of the air has most to do with flake forms. While most flakes are six-sided, three- and five-sided flakes are also common. The biggest and prettiest snowflakes are those that fall on days when the temperature is just below freezing. As air gets colder its capacity to carry moisture is decreased and the result is less fancy flakes.

Acid Snow
When snow forms around pollution particles the flakes fall to the ground and contribute to water pollution. Sulfur dioxide (S02) is a by-product of our industrial society. Fumes from coal burning industries contain S02 and very often it will become the nucleus for a snowflake. S02 combined with H20 (water) results in sulfuric acid (H2S04). A very frightening example of air and water pollution is rain or snow that contains sulfuric acid.

Acidity is detectable in a simple chemical test called a pH test. The pH range is from 1 to 14 with from 6½ to 7½ on the range considered to be most acceptable to life. Very few animals and plants can survive in an environment where the pH is near either end of the scale.

1 2 3 4 5 6 7 8 9 10 11 12 13 14
Most Acidic Neutral Most Alkaline

Moisture and Insulation
Snow serves many functions. It not only stores tremendous amounts of water it also helps countless plants and animals to survive northern winters. Voles, shrews and moles are active under the snow all winter. Ruffed grouse dive into snow to roost during cold nights. People build hollow caves of snow to camp in.

Profiles
Snow, when it stands long enough, develops layers. The top layer is just as might be expected: sharp crystals lying loosely and slowly being compacted by additional falling snow and temperatures. Just below the new snow will be found a layer called "firn". The firn consists of crystals that have lost their sharp edges due to compaction, and is more likely an area of ice crystals rather than snow crystals. Below the firn is an area called the "depth hoare". The crystals in this area are also a different shape due to compaction and to temperature difference. The temperature difference is not due to the air temperature, however, but rather from heat being radiated from the earth! The earth's core is made of molten iron and nickel. Some of this heat escapes and the loss is very obvious where there are hot springs and geysers. The heat which causes the depth hoare in old and deep snow comes from the earth. When the air is cold it is easy to prove this by taking the temperature at the ground level of a snow bank and again above the snow. By cutting a vertical slice of snow it is possible to see a profile and to record the temperature throughout the snow depth.

Activity
After receiving instructions concerning data collection, each team is to collect the information required for each of the three sites on the chart and one additional site. Each team should try to find a fourth site where one of the four tests (pH, water content, temperature or profile) is very unusual, and then try to explain the differences. Do the tests in the following order:

Profile
Draw a picture of the snow at each site. Measure the depth of new snow, firn and depth hoare.

Temperature and Water Content
Record the temperature at each of the levels of the profile and at a distance at least 12 inches above the snow for each site. Take a core sample of water from each site. Place it in the plastic bag furnished. When you return to the classroom, melt the snow and measure the water content. Enter the content on the form.

pH
Use the same meltwater obtained from the core of each site and determine the pH of the sample.

Snow Data Chart

Test	**Site One** Open Field	**Site Two** Wooded Area	**Site Three** Plowed Bank	**Site Four** ____________
pH				
H2O Content				
Profile with depth and temperatures				

Plant Photosynthesis

If it weren't for plants, we wouldn't be here. The earth is about five billion years old and for the first four billion years it consisted only of lifeless chemicals and minerals. Just over one billion years ago the atmosphere, which contained mostly ammonia and carbon dioxide, was unfit for animals.

Somehow, and no one will ever know just how, the compounds present in the water of the earth joined together and formed the first life. Plants were the first living things on earth. The plants utilized the ammonia and carbon dioxide in the atmosphere for their growth. A by-product of their growth was oxygen, an essential element for animal life. After a few hundred million years the atmosphere was basically as it is today and the first animal life appeared on earth.

In addition to preparing the atmosphere for animal use, plants also provide all food. It is obvious that people eat plants. It is also a fact that when people eat meat they are eating plants. A world without plants would be a world without life.

Instructional Sequence

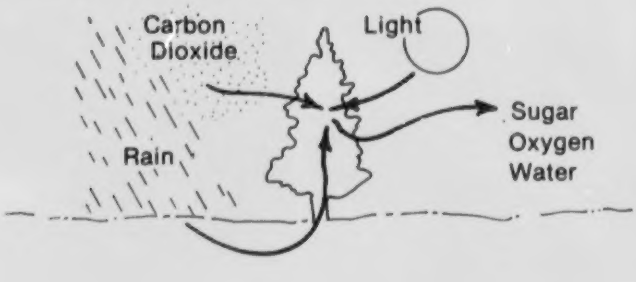
Part I of this activity consists of a teacher presentation dealing with plant history (as presented in the above introduction) and information dealing with photosynthesis, plant growth and transpiration. All of the materials needed for the presentations are included in this introduction.

Part II begins after the instructor has presented the information included in part one. Divide the class into teams of 3-4 students each and instruct the group in the method of measuring annual rings and the use of cobalt chloride paper for determining transpiration rate. The location of the tree cutaways is indicated on the Activity Site Map included in the ELC **Planning Guide and Curriculum.** Transpiration is measured by clipping the paper to a leaf still attached to the plant, placing a plastic bag over the leaf and paper, and recording the time required for the paper to change from blue to pink. The best way to see how this works is to try it prior to the class.

Part III is completed back in the classroom. In addition to checking the data contained on the student sheets, a number of questions are included that require the students to use growth rate and transpiration in obtaining answers. If time permits, go over those parts of the activity that may have proved difficult to the students.

Photosynthesis

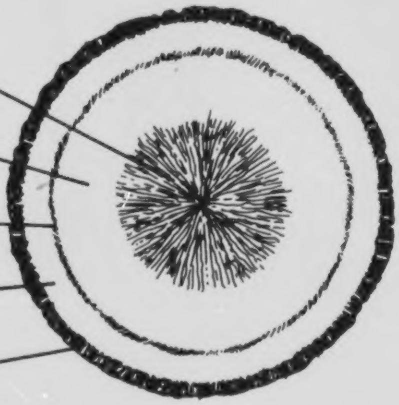
The process plants employ to make food and oxygen is called photosynthesis. "Photo" refers to light which the plant uses to "synthesize", or produce, food. The process, understanding that the plant is rooted in soil, can be illustrated as follows:



This diagram becomes very involved when animals and life processes, like death, are added. It is important for the students to remember that the plant uses carbon dioxide, water and sunlight to produce food in the form of sugar. Oxygen and water are by-products which are released into the atmosphere.

Growth

Photosynthesis can be demonstrated in a number of ways. A tree produces food for itself and gets larger. Most of the annual growth takes place in the spring and summer. Summer growth is slower than spring because there is less water available. Cells of wood produced in the spring are larger because they hold more water. This springwood is light colored as compared with the summerwood which is dark. Together they form the annual ring. The current growing layer is called the cambium. The following definitions and illustration will help the students to better identify the growth process.



Heartwood supports the tree. Its tissues are not alive but are protected by the wood around them.

Sapwood, or xylem, carries water up from the roots to the leaves. As the cells age the sapwood turns to heartwood.

Cambium is the annual growth layer and covers the tree from root to twig.

Phloem carries sugar throughout the tree. As phloem cells age they become bark.

Bark helps keep out water and insects. It also insulates against cold and heat.

Trees grow at different rates. A jack pine in poor soil may be half as large as a jack pine in good soil. A shaded balsam fir grows slowly because sunlight determines how fast food is produced. Black spruces in bogs sometimes grow as little as one inch in fifty years due to lack of proper nutrients.

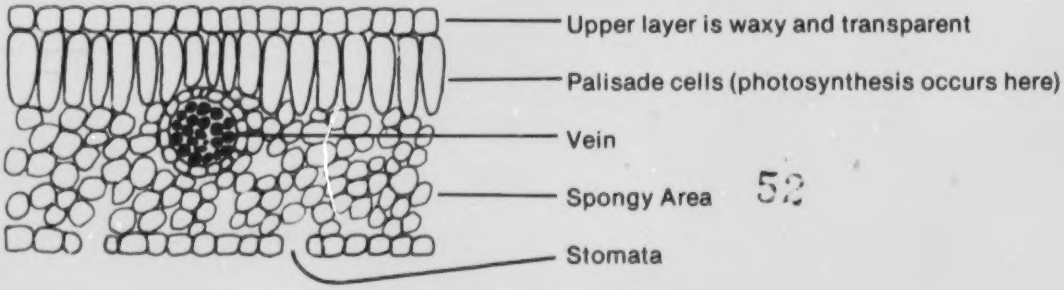
Transpiration

Photosynthesis results in plants giving off water. The process of water escaping into the atmosphere is called transpiration. Most transpiration takes place in the leaves.

The pores that open and close to let in carbon dioxide and let out water and oxygen are stomata. They are usually located on the bottoms of the leaves and the presence of sunlight opens the pores so that photosynthesis can begin. Leaves in the shade have partially closed stomata and will transpire less water and thus produce less food.

During the winter the stomata would freeze and become useless were it not for special adaptations. Where winter is severe, deciduous trees simply drop their leaves in the fall and grow new ones when the weather gets warmer. Evergreens have stomata that are recessed inside the leaf and the leaf has a waxy protective substance as well. Few or no stomata will be found on herbaceous (green) or woody stems.

Close Up of a Leaf


Upper layer is waxy and transparent
Palisade cells (photosynthesis occurs here)
Vein
Spongy Area
Stomata

Part II-Field Trip

Upon completion of the classroom presentation review the student worksheet sections that deal with growth rate and transpiration. **Growth rate** requires that each team visit the cutaways, agree on the age of the tree as determined by counting the annual rings and divide the age into the diameter. **Transpiration** is determined by clipping the sample to be tested to a piece of the cobalt blue chloride paper and recording the time required for the paper to change from blue to pink. The clipping and the paper must be placed in a plastic bag in order to prevent the moisture from evaporating. Instruct the students to do more than one clipping at a time in order to complete all of the required samples.

The best way to start the student teams collecting this data is to do a growth rate for them and help them to time a leaf as it transpires.

Part III

At a predetermined time instruct the teams to return to the classroom and review all of the data collected. Throughout the review process be prepared to go over any and all of the information required of the students in the activity. The following questions will require students to use all of the information they have on their activity sheets. Ask the students to explain their answers.

1. Do evergreens transpire water faster or slower than deciduous trees?
2. Do evergreens produce food faster than deciduous trees?
3. Does sunlight have an effect on transpiration?
4. Where are most of the stomata located on leaves?
5. Is a bog a good place for a tree to grow quickly?
6. Is nutrition or water most important to growth?
7. Is it possible to determine the age of a tree just by its size?

Aquatic Chemistry

For man, a healthy environment means, among other things, clean air. Air has oxygen which all animals need. Very dirty air also has oxygen, but the presence of the pollutants may be so great that the risk of using the dirty air to obtain oxygen will be too great. Confronted with such a situation, a person would most certainly go away from the unhealthy environment and find one where the air has the needed oxygen and is cleaner.

Fish, like all other animals, also need oxygen to live. They take the oxygen from the water, and, like people, if the water is really dirty they will go to another place and find cleaner water from which to obtain the needed oxygen and continue living. If their total environment is dirty they may die.

Fish obtain oxygen from water not by breaking down a water molecule into its component parts of hydrogen and oxygen, but rather by using the extra oxygen atoms that are found between the water molecules. These extra atoms are called dissolved oxygen (DO). The amount of DO available is one factor that limits the types of organisms which may be found in any body of water. Temperature has an effect on DO. Colder water will contain more dissolved oxygen. In order to know the potential DO of a water sample it is essential to know the temperature.

pH is a measurement of "cleanliness". Water with a pH of 7 is considered neutral and a healthy environment. The ends of the pH scale are 0 and 14, with 0 being an indication of acid and 14 an indication of base. Some animals can live if the pH is close to 4 or 9, but hardly any will survive if either end of the scale is reached.

Working in teams students will do a number of tests along a river and in a lake. Using Hac Chemistry Kits and thermometers, temperature, DO (dissolved oxygen) and pH will be measured. In the case of DO the measurement will be compared to a chart indicating the potential amount of oxygen present for a given temperature. When the measurements have been completed each team will, using charts, determine what types of aquatic life should be found at each site and then check their predictions by capturing the organisms and identifying them.

GLOSSARY

pH	The measure of hydrogen ions in a substance. This tells if the substance is acid or base.
DO	Dissolved oxygen. This reading will indicate the amount of dissolved oxygen available for aquatic organisms to use.
Tolerance Level	A level at which a function is possible. For aquatic organisms this level would indicate that they would, or would not be present.

SOURCES

The Golden Guide to Pond Life

Freshwater Ecology William Andrews, editor: Prentice Hall

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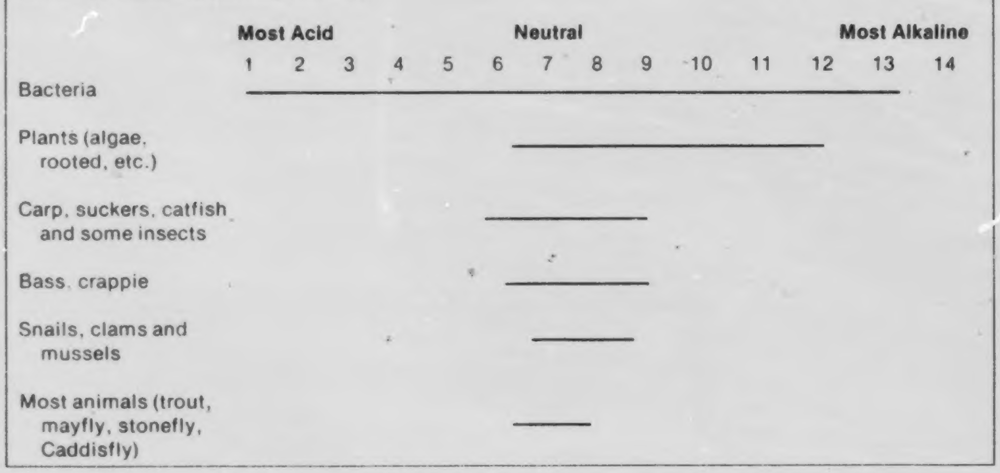
Temperature and Dissolved Oxygen

The amount of dissolved oxygen water can hold varies with the temperature. Colder water will hold more DO. The following charts indicate the amount of DO that should be present in water for given temperatures. When you have determined the water (H20) temperature write in the potential DO as indicated on the following chart. Follow this with an actual measurement of DO. PPM means parts per million. 8 PPM would mean that if there were 1,000,000 parts in the sample, 8 of them would be oxygen.

Site	Temp	Potential DO	Actual DO	pH	Organisms Expected	Organisms Found

pH Ranges that Support Aquatic Life



Temp °C	DO PPM
0	14.6
1	14.2
2	13.8
3	13.4
4	13.1
5	12.8
6	12.4
7	12.1
8	11.8
9	11.5
10	11.3
11	11.0
12	10.8
13	10.6
14	10.3
15	10.1
16	9.9
17	9.7
18	9.5
19	9.3
20	9.1
21	8.9
22	8.8
23	8.6
24	8.5
25	8.3
26	8.2
27	8.0
28	7.9
29	7.7
30	7.6

DO Ranges for Native Aquatic Life

Cold-water organisms including trout with a temperature below 20° C

Spawning . . . . 7 ppm and above
Growth and well-being . . . . 6 ppm and above

Warm-water organisms including game fish such as crappie and bass with a temperature above 20° C

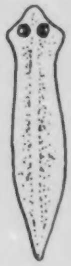
Growth and well-being . . . . 5 ppm and above

Temperature Ranges for Native Aquatic Life

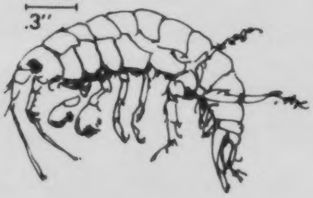
More than 20° C	Many plants, bass, crappie, bluegill, carp, sucker, caddis fly, and many fish diseases
14°C - 20°C	Some plant life, some fish diseases, trout, walleye, northern, stonefly, caddisfly, water beetles, water striders
Less than 14° C	Trout, caddis fly, stonefly and mayfly

Water Organisms Found Near the Environmental Learning Center

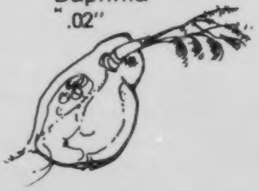
Planaria



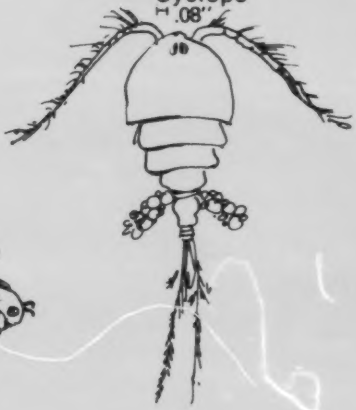
Scud
.3"



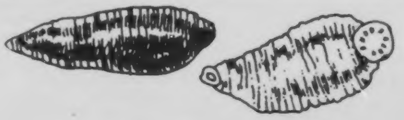
Daphnia
.02"



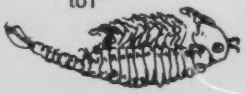
Cyclops
.08"



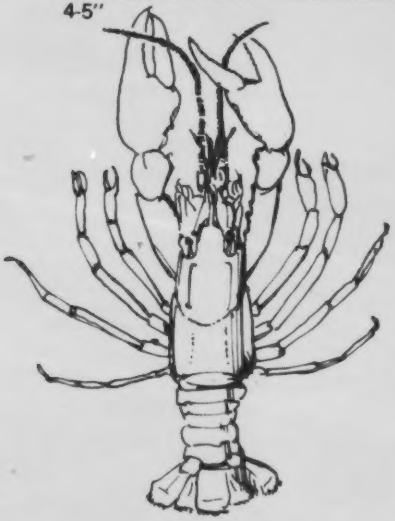
Leech up to 4"

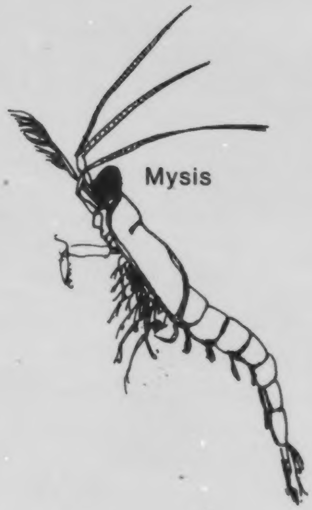


Fairy Shrimp
to1"



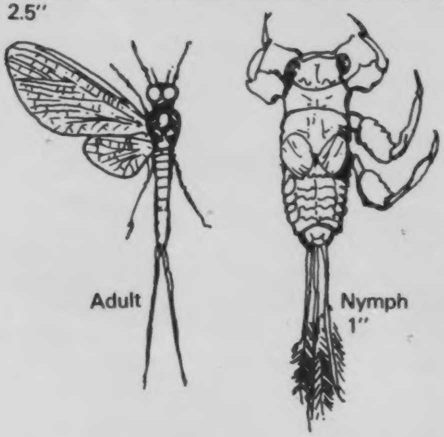
Crayfish
4-5"



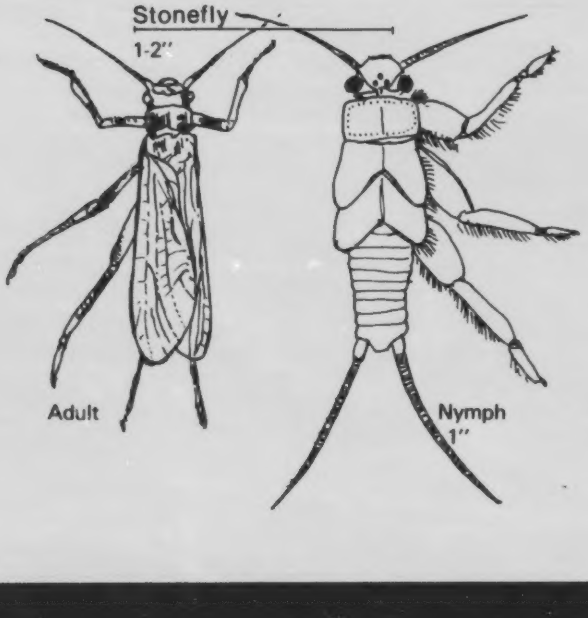


Mysis

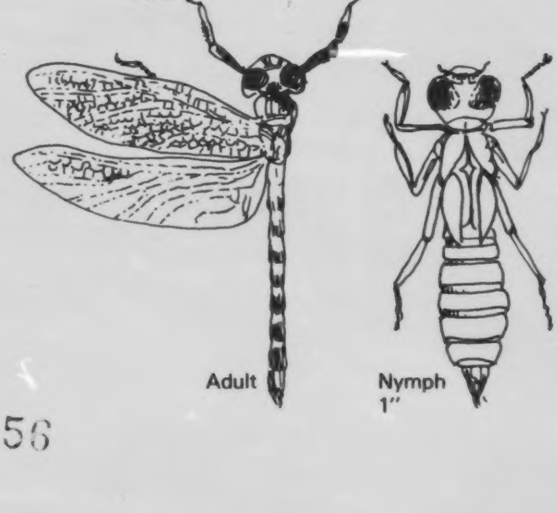
Mayfly
2.5"



Stonefly
1-2"

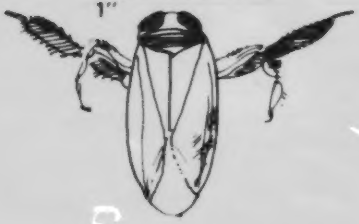


Dragonfly
2.5-3"



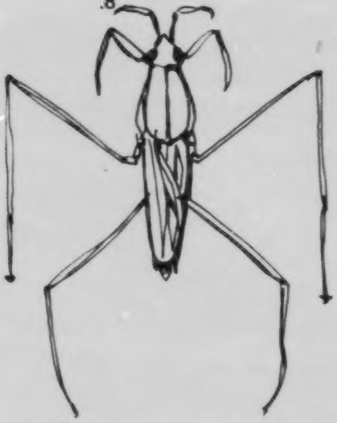
Water Boatman

1"



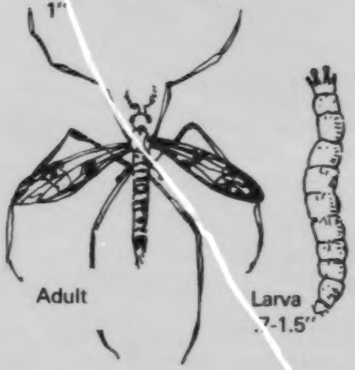
Water Strider

.8"



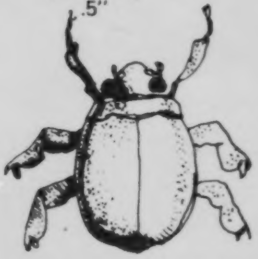
Cranefly

1"



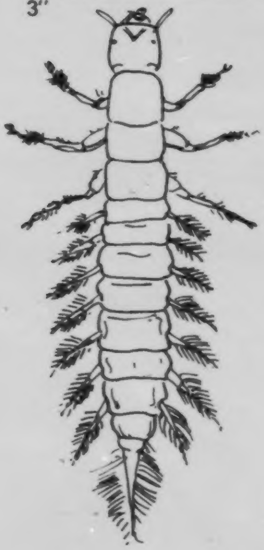
Whirligig Beetle

.5"



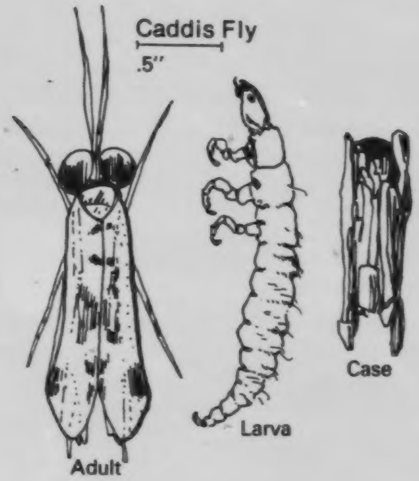
Hellgrammite

3"



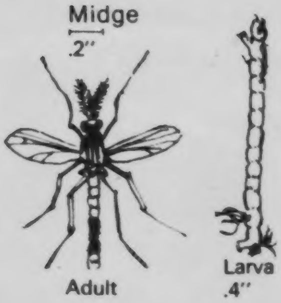
Caddis Fly

.5"



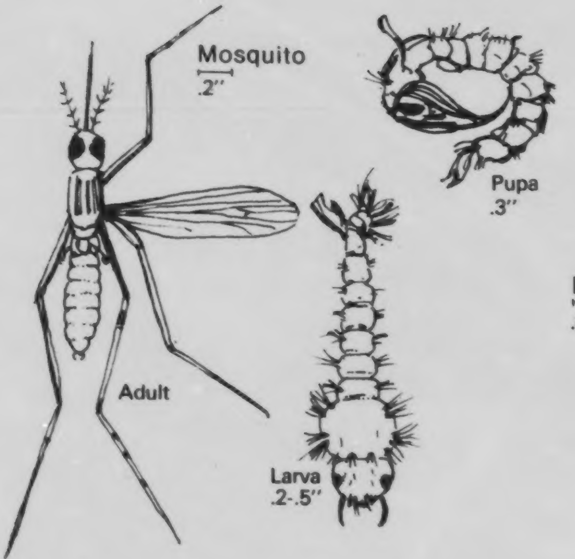
Midge

.2"



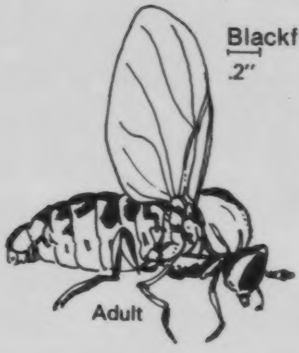
Mosquito

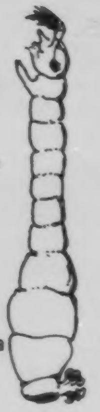
.2"



Blackfly

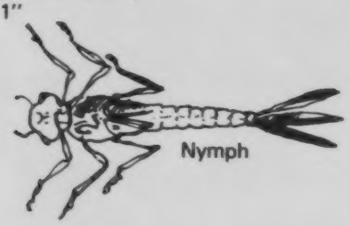
.2"





Damselfly

.8-1"



Basketry

Long before the white man arrived in North America, native people were storing food and personal belongings in containers that are even today enjoyed for their beauty and utility. The Ojibway people living in northern Minnesota made extensive use of birchbark, using it as a building material for their homes, canoes and containers. Some area Indian people adopted a method of making baskets from the splint of the black ash tree. The method of weaving black ash splints into containers is similar to the technique applied to weaving other materials developed by cultures around the world.

Beginning with a slide presentation, students will be introduced to the natural history of the black ash and/or birch tree and the use of the tree for utilitarian purposes. Depending on availability of materials and the wishes of the group, students will be instructed in the making of a simple basket from either black ash splint or birch bark. All steps from selection and collection of raw materials to finishing off will be covered.

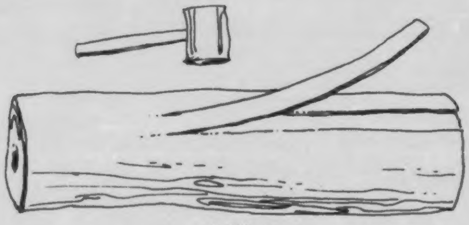
Making a Birchbark Basket

Ojibway people used to store or cache food supplies like maple sugar and rice in bark containers called **makoks**. These makoks were made from a single piece of bark, stitched with spruce root or the underbark of basswood trees, and with a strip of willow or other wood to support the mouth of the container. After filling the container, a top would be stitched on and the package buried for storage until the food was needed some months later.

Step 1 A piece of bark of the necessary size is laid out flat and the makok pattern is traced upon it. The bark is then cut out and sharp bends are scored with an awl.

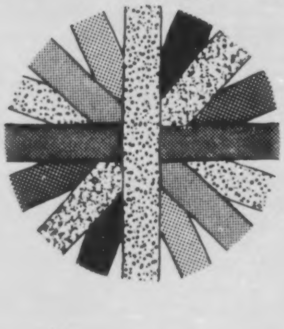
Step 2 The ends are folded up and stitched in place. An awl is used to punch holes for the stitching. Spruce root is prepared and used for the stitching material.

Step 3 Once the container is stitched, a strip of black ash, willow or some other wood is lashed to the rim to provide extra support.

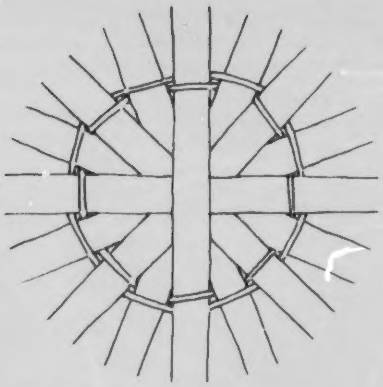


Making a Black Ash Basket

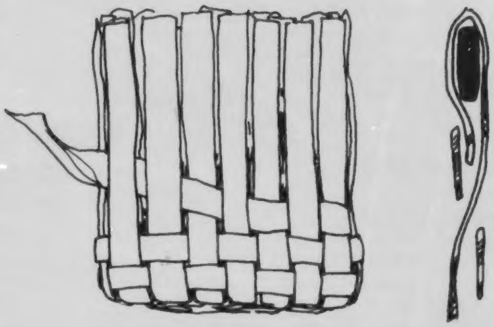
Step 1 The selected black ash log is stripped of bark and its cambium and phloem areas removed. The log is then pounded with a wooden mallet to loosen the annual ring layers which lift off in long strips. The strips may be split and cut to size in preparation for weaving.



Step 2 The splint is laid out like the spokes of a wheel. The center of the wheeel forms the base for the basket's bottom; the outer reaches will become the basket's sides. Eight splints should be laid down, each succeeding pair making an "X".



Step 3 The width of the spokes determines the diameter of the basket. A thin ash cord binds the spokes with a basic over-and-under weave. From there the spokes are bent upward to form the sides of the basket.



Step 4 Weaving continues with wider strips, until the desired height is reached. New splint are overlapped into the weaving to prevent the basket from pulling apart, and starting new splint at the same point each time is to be avoided.

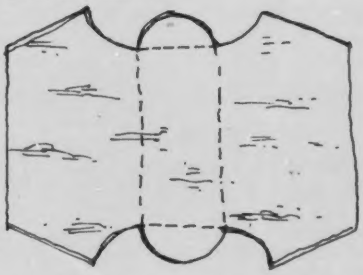
Step 5 A heavier splint is used at the top rim for extra strength. Enough vertical splint is left over to turn over the top edge and weave into the top circumference splints.

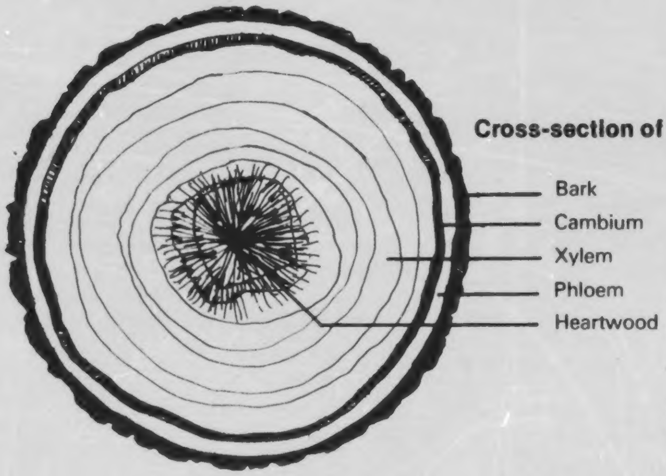
Sources
Crafts of the North American Indians Schneider

Glossary

Makok	Container used by Ojibway people
Cambium	Growth layer of a tree trunk
Phloem	Layer of the tree trunk that carries food for the tree
Splint	Strips of material used for weaving.

Makok Pattern




Cross-section of a Tree

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Basic Camping

Camping, when practiced correctly, provides pleasure and comfort in the most primitive surroundings. Usually camping also causes the rapid deterioration of the camping site, making it less desirable as a place to enjoy nature. A steward is one who is responsible for the well-being of other people or of something of value. Stewardship, as it relates to camping, means that the camper is responsible for his or her own actions as they relate to the environment. Each component of this activity will be taught in such a way as to assure, as much as is possible, that the camping environment is not, in any way, changed by the campers' use.

Students will be instructed in the areas of (1) basic nutrition and cooking, (2) selecting a shelter site and erecting a shelter, (3) selecting and using stoves, packs and sleeping bags, and (4) camping stewardship.

NOTE: This activity can be instructed during one 3-hour session. It can also be instructed during one 24 hour period beginning at 1 p.m. on the first day and ending at 11 a.m. on the second. The 24 hour option will enable students to actually camp-out and to prepare two meals as well as experience camping stewardship.

Basic Nutrition

Food provides the body with fuel to do work. The amount of energy used is measured in a unit called calories. A person that spends all day in bed will "burn up" about 1500 calories and a cross country runner will expend about 1500 calories during a 2 hour run. Students will learn about calories as units of energy and the roles of proteins, fats, carbohydrates, vitamins and minerals. After the basic body requirements are considered the students will discuss methods of cooking and practice with a trail stove. Students in the extended class will prepare a supper and breakfast in the field and students in the half day session will prepare a light meal.

Shelter

In addition to learning how to properly select a site, students will be instructed in the method of properly erecting a tent or, if snow conditions are right, how to construct a snow shelter. They will also learn the six basic human needs and relate them to the experience of camping. There will be special attention paid to insulation and heat loss.

Equipment

Students will learn about natural and man-made insulation fibers used in sleeping bags, the role of the sleeping mat as an insulator, the usefulness of "soft" and frame packs and the use of stoves as compared to fire for cooking. Clothing, as a shelter, will also be considered for the season.

Stewardship

This is the most important section of this lesson. Most people are certain that they already know how to act in the woods. In fact, most people don't even come close to doing all they could to preserve the environment so its enjoyable use will continue unchanged. Using the **Wilderness Ethics** guide produced by the Minnesota Department of Natural Resources as part of the Heritage Series, students will learn about camp and trail ethics. Included will be information on trail erosion, noise, fire, multiple use or abuse, food protection, garbage disposal, washing and bathing and the camper's responsibility to self and others.

Sources

Minnesota Heritage Series, **Wilderness Ethics, Survival in Minnesota's Outdoors**, and **Nutrition for Outdoor Recreation**, all available from the Minnesota Department of Natural Resources.

A Special Note about Sleeping Bags and Clothing

Many students have sleeping bags that are designed for slumber parties and are not sufficient for sleeping out of doors. Be certain that students have a winter weight bag if they will be camping out during any time except the summer. In addition to the sleeping bag it is also essential that each student have adequate clothing. We recommend, as a minimum, the following:

Winter

Winter weight sleeping bag
Long underwear
Wool or corduroy pants (not denim)
Wool socks, at least 2 pair
Warm boots
Mittens (not gloves)
Wool stocking hat
Heavy shirt
Heavy sweater (wool is best)
Knit scarf
Winter jacket (snowmobile suit is good)

Summer

Medium weight sleeping bag
Adequate clothing
Rain gear

NOTE: Early spring and late fall should be treated the same as winter. Students that are not properly prepared for camping out will not be permitted to do so.

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Beginning Canoeing

The first boat was most certainly a log that the user swam beside and then rested upon. The log was followed, and no one knows how much later, by logs tied together with vines to form a raft. The raft was moved through shallow water with poles, and, when deeper water was encountered, the Traveler discovered the need for a pole with a wide blade and likely made the first paddle. The raft developed at the same time that the log changed from a simple flotation device to a boat. Indians of the Northwestern coastal regions of North America made dugouts of excellent design with elaborate totem carvings. Dugout canoes used in the Pacific Islands have outriggers to provide stability.

Canoe building reached its highest form in North America. The birch bark canoe could be as long as its owner desired, was light enough to carry over portages and was very maneuverable. This craft was so important to the natives of the northern United States and southern Canada that their culture is often referred to as the Canoe Culture.

Students will be instructed in the areas of (1) Canoe structure and selection, (2) Maintaining stability in a canoe, (3) Basic paddling strokes, and (4) Flotation devices.

Structure and Selection

Aluminum and plastics are the most common materials used in the construction of a modern canoe. Birch bark canoes are normally seen only in museums and high quality cedar strip canoes with canvas or fiberglass covering are much less common than the aluminum and plastic models. Aluminum canoes, very common in Minnesota's canoe country, are formed in two halves and held together with about 2000 rivets. Plastic canoes are normally constructed in molds. Definitions that deal with canoe structure include the following:

Stern	The rear or back end of a canoe
Bow	The front end of a canoe
Gunwales	Structural supports for the sides of a canoe. Located on the uppermost portions of the sides and extending from the stern to bow on both sides.
Hull	The body of a canoe
Keel	A strip running from the stern to bow along the bottom of a canoe to protect the bottom and to prevent sideslipping.
Ribs	The frame of a canoe extending from gunwale to gunwale and forming the shape of the craft. Many plastic canoes do not need ribs as the hull is strong enough to provide the support and shape. Aluminum canoes have few ribs and wood canoes have many.
Beam	The widest portion of the canoe from gunwale to gunwale.

Maintaining Stability

Canoes are lightweight, shallow-draft crafts which are very sensitive to weight distribution and the effects of wind and waves. The paddlers' positions affect the fore and aft trim as well as side to side trim. Because safety must be foremost in a canoeist's mind, an understanding of weight distribution and stability is essential. Students will be introduced to proper positioning for solo paddling, tandem paddling, three in a canoe and changing positions in a canoe.

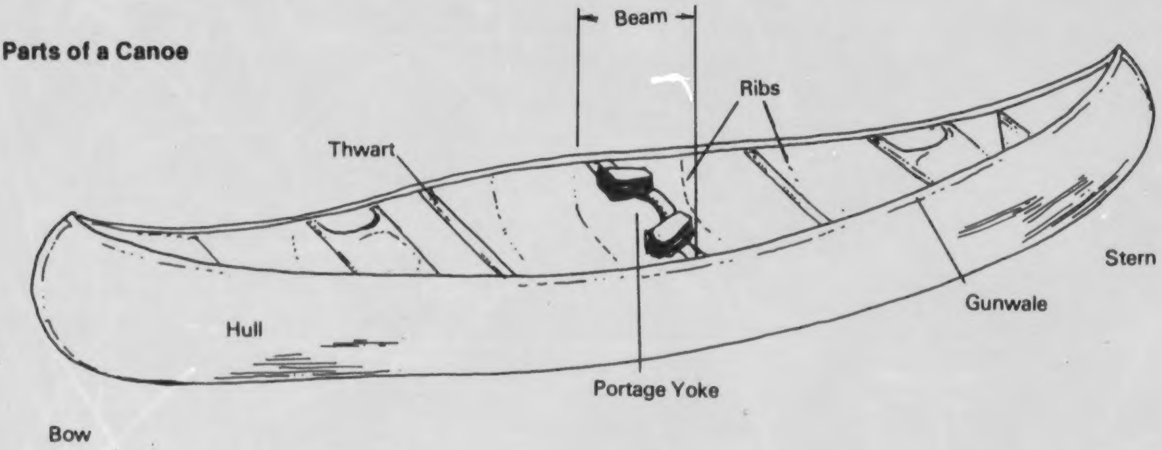
Trim	The fore and aft angle in which a canoe rests or moves on water - for example, a canoe can be stern-heavy or down at teh stern as opposed to being evenly trimmed.

Basic Strokes
There are four directions in which a person can make a canoe move. Combinations of basic strokes can cause the canoe to move diagonally forward or backward or can make it turn. Students will be instructed in the forward stroke, the backward stroke, the J stroke, the draw stroke and the pushaway stroke.

Flotation Devices
According to law it is necessary to have life jackets on board for each person. Students will be introduced to the types of jackets available and understand the use of each.

Sources
Canoeing The American National Red Cross

Parts of a Canoe



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Beginning Cross Country Skiing

Cross country skiing is at least 5000 years old. Archeological evidence indicates that the people in what is now Scandinavia used skis almost exclusively for winter travel. Unlike downhill (alpine) skiing, the nordic skier is able to put on his skis and ski. Downhill skiers must spend a lot of time waiting in lines, riding lifts to the top of the hill and often just getting warm! Cross country has become, for many, a favorite winter pastime.

Students will be instructed in the areas of selecting equipment, using wax, and basic ski techniques.

Equipment

For cross country skiing it is necessary to have skis, ski boots, bindings to hold the skis to the boots, poles and a ski waxing kit. SKIS are available either in wood or fiberglass and are usually 8 to 12 inches longer than the skier's height. The metric system of measuring which originated in Scandinavia is used exclusively. Most quality skis are made of laminations (see illustration) with those having between 20 and 32 laminations considered of the best quality. The laminations provide the essential springiness and camber. Camber is the slight bow-shape that permits the skier's weight to be equally distributed over the ski. BOOTS should be light, flexible and have some padding. BINDINGS are generally of two types: cable around heel and the toe binding. POLES should reach to the center of the skier's shoulder, and bamboo poles, because they are light and springy, are usually best for the beginner.

Wax

It is necessary to wax the bottoms of most skis before going onto the snow. The bottom surface of wooden skis must be prepared in order to make the bottom water-proof and to provide a surface to which the wax will adhere. Waxing, for ski racers, is possibly the most important aspect of skiing. Briefly, the colder the snow the harder the wax must be. Cold snow has sharp crystals which will stick into a hard wax and help the skier go uphill. Warmer snow is not as sharp and a softer wax is needed in order for the snow to "bite" the wax and help the skier. Fiber glass skis do not require a bottom preparation before waxing and some glass skis do not require wax, although most serious skiers prefer to use skis that require wax in order to obtain the greatest amount of glide from their equipment.

Basic Ski Techniques

Ideally a beginner should start skiing on a training loop. After becoming comfortable on the skis students will be taught the DIAGONAL STRIDE which is the basic movement used to go ahead on skis. The stride will be followed by the SNOWPLOW, which slows movement when going down hill and the HERRINGBONE, which is helpful when moving up a hill. KICK and STEP TURNS will be demonstrated as will the pole use techniques most effective with each of the above methods.

Sources

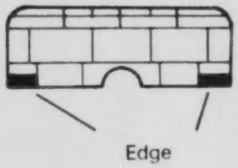
Nordic Skiing, by M. Michael Brady
Complete Cross-Country Skiing and Ski Touring, by Lederer and Wilson

Glossary

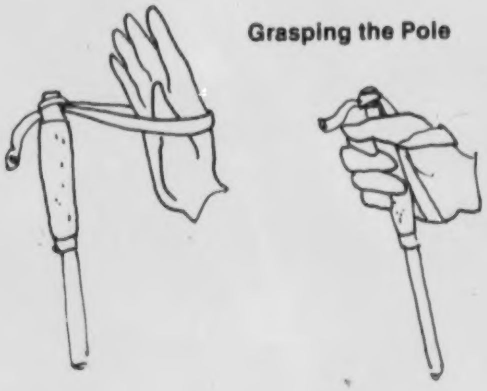
Alpine Skiing	Primarily downhill

Nordic Skiing	Skiing up and downhill (cross country)
Touring Ski	Used for Nordic skiing. "Light" touring skis are used by most active skiers.
Camber	The slight bow shape of the ski. The amount of camber depends upon the type and length of the ski which is determined by the height and weight of the skier.
Basket	The circular device near the bottom of a ski pole which prevents the pole from sinking into the snow more than a few inches.
Waxless Ski	A ski with a patterned bottom that eliminates the need for wax. Ski "purists" do not use waxless skis.

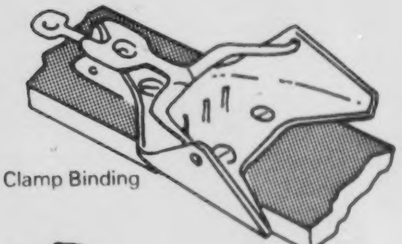
Ski Cross-section

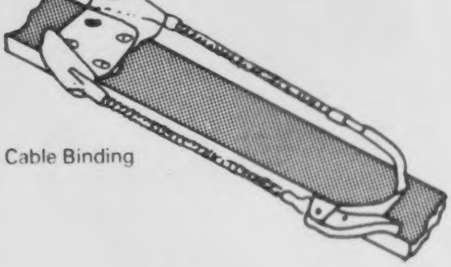


Grasping the Pole

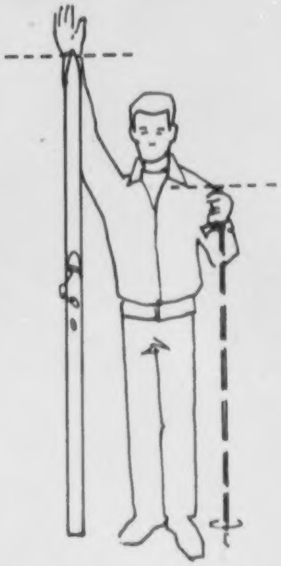


Ski Bindings


Toe Clamp Binding


Cable Binding

Ski and Pole Length



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Beginning Orienteering

"Orienteering," that is, finding a route across familiar or unfamiliar territory by imaginative and intelligent use of map and compass, is important for safe navigation outdoors. Hunters, fishermen and hikers are able to be more successful if they understand and use orienteering. Orienteering, which combines map and compass work with cross country running, is also becoming increasingly popular in a number of countries.

In Beginning Orienteering students will learn (1) the parts of a compass, (2) how to find a bearing with a compass, (3) how to determine the average length of their pace for application to determining distance, and (4) basic map interpretation. They will also complete a simple orienteering walk using a compass and pacing.

Parts of a Compass

The modern orienteering compass consists of three basic parts: a magnetic needle, a revolving compass housing, and a transparent base plate - each part with its own special function, but all three working together to make the compass an efficient and useful instrument.

Finding and Following a Compass Bearing

A compass is oriented when the red needle is pointing **N** and the direction indicator arrow is pointing in the direction to be traveled. To reach the destination simply proceed straight ahead in the direction in which the direction of travel arrow points. Frequently it is advisable to use points between the start and finish point. If, for example, there is a large rock directly in the path the student may go to the rock and then check the path ahead with the compass. To return to the starting point the student can simply return with the arrow pointing at the student rather than at the original destination. This may sound confusing, however, heading in the direction of the indicator arrow and then turning and going the opposite direction will demonstrate the method.

Pacing

A pace is the distance between the same foot when walking, or said in another way, the length of two steps. The first use of pacing, the measurement of one foot, and the mile are credited to the Romans. One thousand double steps (paces) of the average Roman soldier was equal to 5,280 times the length of the soldier's foot! The Latin for one thousand double steps or paces, **millia passuum**, was later abbreviated into the English "mile." In order to determine the exact length of pace, students will use a step course and measure the length of their pace.

Walking Course

A number of walking courses will be provided. Students will be required to take a bearing and then pace a specified distance to a marker.

Map Interpretation

Students will be asked to remember the five D's of map reading:

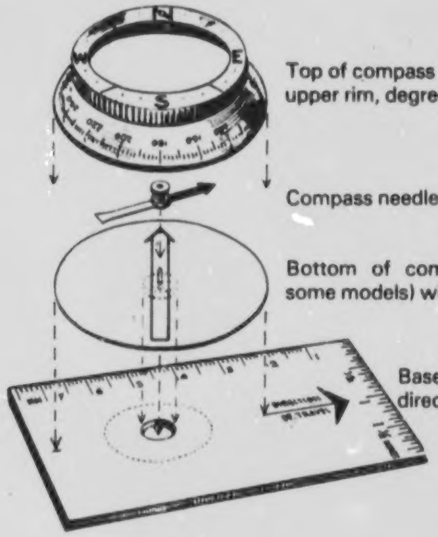
Description, Details, Directions, Distances and Designations.

The DESCRIPTION is normally found in the margin of a map. DETAILS include symbols of man made features, water features, vegetation features and elevation features. DIRECTIONS tell declination, and it is always assumed that North is at the top of the page. DISTANCE is determined with scale, and different DESIGNATIONS are usually indicated with different lettering styles. In addition to understanding the five D's, students will also learn the meaning of map scale, declination, contour interval, true north, and the township-range system.

Sources

Map and Compass, by Bjorn Kjellstrom

Parts of a Compass



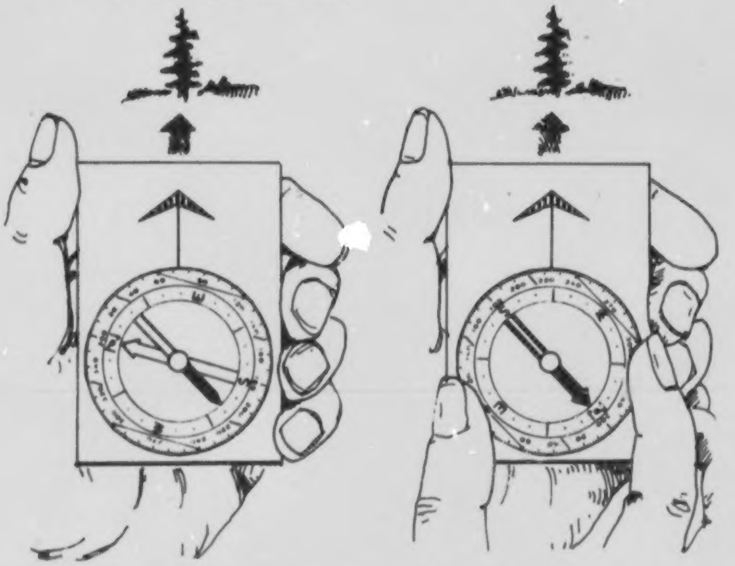
Top of compass housing - with cardinal points on upper rim, degree dial around lower rim.

Compass needle with colored north part.

Bottom of compass housing (transparent on some models) with orienting arrow.

Base plate with direction-of-travel arrowhead, direction line (index pointer) and ruled edges.

Finding a Compass Bearing



To find direction with Orienteering compass, point direction-of-travel arrowhead to landmark, turn housing until needle lies over orienting arrow. Bearing to tree 225°.

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Orienteering Courses

The following courses are set for use near the ELC. Ideally, students should have completed sessions in which they learn (1) the parts of a compass. (2) how to find a bearing, (3) how to pace, and (4) basic map interpretation.

Course 1
A simple course in which students are to take one reading and then pace the indicated distance. They should arrive at a marker and record the information on the marker before using it as the start of the second "leg".

Point	Heading	Distance	Identification
S-A	212°	232'	
A-B	125°	175'	
B-C	143°	127'	
C-D	23°	51'	
	106°	106'	
D-E	82°	140'	
E-F	308°	454'	
F-G	326°	235'	
G-H	252°	200'	
H-I	342°	150'	
I-J	44°	195'	
J-S	146°	345'	

Course 2
This course uses the same set of markers as the above course. It is more difficult because it uses "dog legs".

Point	Heading	Distance	Identification
S-A	225°	159'	
	182°	121'	
A-B	45°	103'	
	169°	76'	
	140°	153'	
B-C	143°	127'	
C-D	23°	51'	
	106°	106'	

Point	Heading	Distance	Identification
D-E	47°	67'	
	108°	115'	
E-F	308°	454'	
F-G	348°	100'	
	312°	155'	
G-H	228°	81'	
	286°	97'	
	220°	68'	
H-I	336°	81'	
	347°	79'	
I-J	70°	110'	
	19°	114'	
J-S	146°	345'	

Course 3

This course uses natural markers that must be identified as well as letter markers. A, K and C are good starting points and completion will bring the students back to the start. The course may be run backwards by subtracting 180 from those bearings which are more than 180 and by adding 180 to those which are less. This course lends itself to an orienteering race simply by starting teams of students at different points and timing them.

Point	Heading	Distance	Identification
A-B	82°	335'	
B-C	148°	401'	
C-D	196°	135'	
	247°	107'	
D-E	114°	161'	
E-F	272°	281'	
F-G	360°	134'	
G-H	348°	182'	
H-I	290°	109'	
I-J	222°	175'	
J-K	320°	200'	
K-A	39°	234'	

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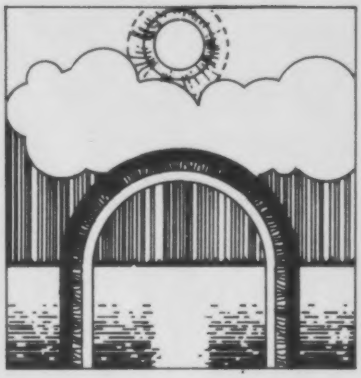
Nature's Water Cycle



The story of water is the story of man. From the beginning man found it necessary to move his habitation from water only when the acts of nature, or himself, caused a change in the quantity or quality of the water. In today's society, natural changes are more easily dealt with. Pollution caused mostly by people has recently become man's major water concern.

Water is constantly moving, both through time and space. The water that is located in a nearby lake today will be someplace else next year. Water drawn from a faucet today will, in all likelihood, be drawn from other faucets in future times. It is almost a certainty that in some other place and time a dinosaur was wetted by some of the water located in Lake Superior today.

Students will use basic mathematics and determine how water moves through the cycle. Streamflow will be measured enabling the students to determine the volume of water moving by a given point in a given period of time. Using the stream flow data and lake measurements, they will determine how much water the lake holds as well as how often the lake "flushes".

Determining the Volume and Velocity of Moving Water
In this activity students will visit three different river locations and record width, depth and flow velocity to determine the flow rate in cubic feet per second.

Determining the Flush Time of a Lake or Pond
Using information provided on the student worksheet, students are able to determine the volume of water in a study lake. Using the rate of flow previously determined and the lake measurements (acres and depth), students are able to determine the lake's flush time. Prior to determining flush time students will be asked to record indications of water in the environment.

Activity Sites
Flathorn Lake
Flathorn Lake drains 19,723 acres. It has an area of 55.6 acres. The lake's average depth is six feet; 35.5 acres are more than five feet deep and 4.1 acres are more than ten feet deep. Flush time is 24/year and is most rapid at times of high water.

Little Isabella River
The Little Isabella drains 13,825 acres. Its source is a low swampy area south of the community of Isabella. The river flows into the Isabella River in the BWCA which flows between Lake Isabella and Bald Eagle Lake.

Weiss Creek
Weiss Creek is a small stream that is about five miles long and drains 3,814 acres.

Measures
One acre foot = 43,560 cubic feet of water, or 325,851 gallons.
One cubic foot of water = 7.48 gallons and weighs 8.33 pounds.

Glossary

Lake a body of standing water isolated from the sea and having an open area devoid of plant life. The water is relatively deep.

Pond a small and shallow body of standing water. The presence of higher aquatic plants is common.

Swamp ground that is wet most of the time and occupied by woody plants.

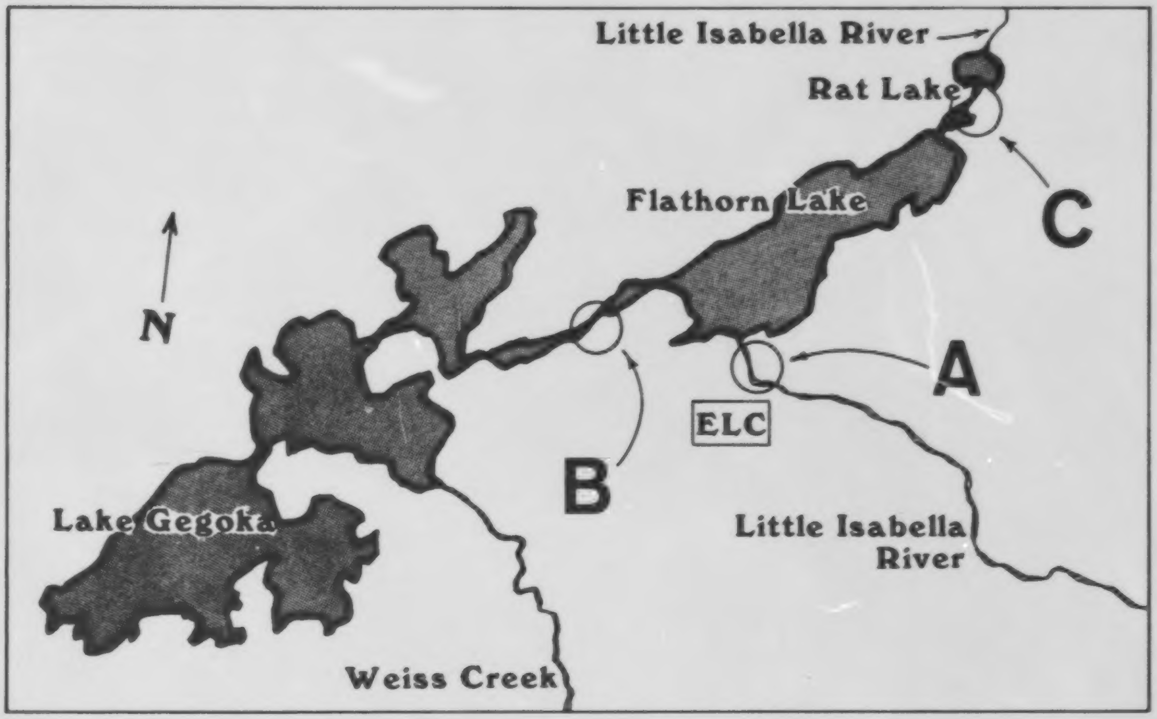
Marsh a swamp in which the predominant vegetation is grass-like.

Bog a swamp with unfavorable soil and aeration which hinders decomposition of organic matter. Bogs contain sphagnum moss, acid-loving shrubs, sedges, coniferous trees and certain insectivorous plants. Bog succession is such that certain plants dominate for periods of time.

Sources

Freshwater Ecology	William Andrews, Prentice - Hall, Inc.

Activity Sites



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Volume and Velocity of Moving Water

During most of the year, the Little Isabella River is a slow moving stream that begins in lowlands southeast of the Center and ends where it joins the Isabella River in the Boundary Waters Canoe Area. The fishing is good, but the river can be canoed in only a few places. The drainage area of the river is 13,825 acres, excluding lakes it flows through.

In this activity you will measure water volumes where water enters and leaves Flathorn Lake. The three study sites are: (A) where the Little Isabella enters Flathorn at the southeast corner of the lake; (B) where Weiss Creek flows into Flathorn; and (C) where the Little Isabella leaves Flathorn Lake.

Collecting and Recording Streamflow Measurements

Site where your data is collected:

_____ [A] Little Isabella inlet _____ [B] Weiss Creek inlet _____ [C] Little Isabella outlet

Step 1

Measure and mark a 20 to 50 foot distance along a relatively straight section of your stream. Be sure your section is not part of the lake! Place a float into the water above the upstream marker and record the number of seconds it takes to float downstream between the markers. Record the time in the space below. Divide the distance by the total seconds it took the float to travel between the markers. Do this three times and find the average time.

1st measurement _______ (distance) ÷ _________ (total seconds) = _______ **ft. per second**

2nd measurement _______ (distance) ÷ _________ (total seconds) = _______ **ft. per second**

3rd measurement _______ (distance) ÷ _________ (total seconds) = _______ **ft. per second**

Total of three speeds __________ ÷ **3** = __________ **ft. per second [average speed]**

Step 2

Find the average width of your section of stream. Measure the width of the stream at three different spots within your marked length. Add the measures and divide the sum by three to get the average width.

1st width _______ **ft.** + **2nd width** _______ **ft.** + **3rd width** _______ **ft. equals** _______ **ft.**

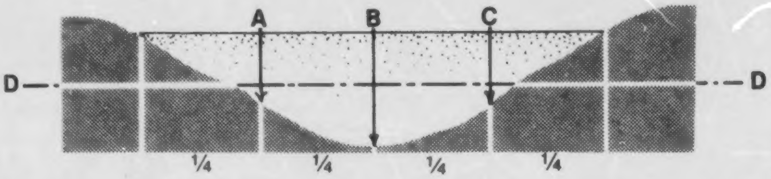
Total _______ **ft.** ÷ **3** = _______ **ft. [average width]**

Step 3
Find the average depth of your section of stream. Measure the depth of the stream at three points across the middle of the stream following a straight line. Divide the total by four to get the average stream depth.

1st depth ________ ft. + 2nd depth ________ ft. + 3rd depth ________ ft. = ________ ft.

Total depth ________ ft. ÷ 4 = ________ ft. [average depth]

NOTE: The reason you take three depth measurements and then divide by four is to take into account the shallow areas of the stream. This is explained in the drawing below. If the depths at points A, B, and C total 20 feet, and that number divided by three, the result would be 6.66 feet. However, the correct average depth, as shown by line D, is five feet, which is obtained by dividing the total depth measurement by four.



Step 4
Find the volume of flow in cubic feet of water per second. Multiply the average width, average depth, and average rate of flow together.

________ ft. X ________ ft. X ________ ft. per second = ________ cubic ft. per second
width depth speed

NOTE: A cubic foot of water would fill a container one foot square and one foot deep, and it contains 7.48 gallons of water. One liter = 1.06 quarts, and there are 1000 liters, or 236 gallons, in a cubic meter.

Step 5
The average person in the United States uses 200 gallons of water per day for household use. Complete the following calculation, to find out how many people could live on the water flowing in your stream section.

________ X ________ = ________ gallons of water per second
stream flow in cu. ft. per sec. gallons in 1 cu. ft. of water

________ X ________ = ________ gallons per minute
gallons per second seconds in minute

________ X ________ = ________ ÷ 200 G = ________ people
gallons per min. minutes per day gallons per day per person

Flush Time of a Lake or Pond

It's easy to look at a lake or pond and imagine that the water has been there for a long time. But really, water is constantly moving through the hydrologic cycle, changing both location and form.

The human body is over 97% water. All living things and places on earth contain water in one form or another. Precipitation is water falling from the sky and is recognized as snow, sleet, rain and fog. Evaporation is water being returned to the atmosphere from lakes, streams, bogs, plants and animals. Water in its solid form, ice, may not move through the cycle for a long period of time. Imagine! The water that you will drink today could very well have been used to cool a steel mill 50 years ago or have quenched the thirst of a dinosaur 250 million years ago!

Observing Water in the Environment

Step 1

Water is "used" in different ways. List examples of how water may affect a person's senses. One is done for you.

Sight Excitement in seeing a waterfall; apprehension seeing a storm coming; calm feeling when viewing a quiet lake.

Touch

Smell

Hearing

Taste

Step 2

Seeing water in a lake or stream is easy. "Seeing" the water that is located in the ground, in people, in animals, and in the air is more difficult. Prove, if you can, that there is water in each of the following and tell why it is important.

Atmosphere

Soil

Plants

Animals

Determining the Flush Time of Flathorn Lake

Step 1
In order to determine the length of time required for the water located in a lake to be replaced by the same amount of different water, it is necessary to know how much water the lake holds and how rapidly water leaves the lake. Most of the water leaving Flathorn Lake leaves via the Little Isabella River.

Using the following information, determine how much water there is in Flathorn Lake.

AREA: Flathorn Lake has an area of 55.6 acres.
DEPTH: Flathorn Lake has an average depth of 6 feet.
ACRE FOOT: One acre foot of water is the amount of water located in one acre, one foot deep, or 43,560 cubic feet.
CUBIC FOOT: One cubic foot of water is equal to 7.48 gallons.

area ________ **X** **depth** ________ **=** ________ **acre feet**

____________ **acre feet** **X** **43,560 cubic feet** **=** ____________ **total cubic feet**

____________ **X** ________ **=** ____________________

total cubic feet **gallons per cubic foot** **total gallons of water in Flathorn Lake**

Step 2
Formula for Determining Flush Time

____________________ ÷ ____________________ = ________________

total gallons of water in Flathorn **gallons per day leaving Flathorn via the Little Isabella river** **total days required to empty the lake**

List as many factors as you can that would make the above total more accurate.

____

____

____

____

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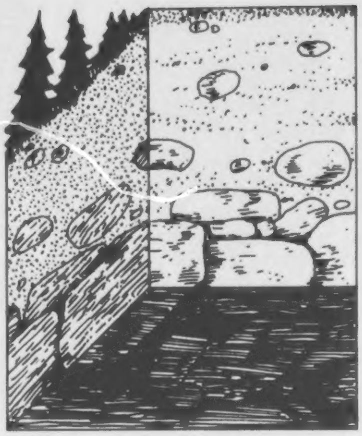
Soil Ecology



Soil is the basic component of the natural environment. It acts as a bridge between the organic and inorganic worlds. Soil formation begins with the weathering of rocks and minerals. Influenced by vegetation and climate, soils differ in texture, structure and color. A solid rock will eventually wear away and support vegetation. A sandy beach, consisting mainly of weathered inorganic material will eventually become soil and support plant life. Collecting soil data and analyzing it is important in understanding the relationships between the soil and the plants and animals in an ecosystem.

While participating in this activity students will measure soil pH, soil temperature, soil percolation, soil texture and color. They will examine soil and compare the amount of organic and inorganic materials present at a variety of sites.

pH

pH is one of the more important qualities of soil, as most plants have a very narrow pH range. Blueberries, for example, grow best if the pH is between 5.0 and 6.0. Soil with a pH of 7 is considered neutral. If the pH is below 7 it is said to be more acidic and above 7 more alkaline. As the indicator number approaches 1 or 14 (the bottom and top of the scale) the concentration of acid or alkali increases. Seldom will any plants grow if the range is below 4 or above 8. Students will record pH at a number of sites and record the types of plants associated with each site.

Soil Temperature

Soil both warms and cools more slowly than the air. Soil will often be found to be warmer than the air if the soil is located in direct sunlight and insulated with loose "duff" consisting of forest plant debris. Students will record temperatures 12 inches above the ground, at ground level, 3 inches below ground level and 6 to 7 inches below ground level. Temperatures will be related to the presence of organisms and plant growth rates.

Percolation

Percolation is the rate at which water is absorbed by the soil. Soil that permits rapid movement of water, such as sand, will not support as much plant life as soil that takes and holds water, making it available for plant use. Clay soils do not have spaces between particles and thus water will just run off and not be available to the plants. Percolation is measured by placing a tube into the soil and pouring a known amount of water into the tube. The time required for the water to be completely absorbed is recorded and then compared with other sites.

Soil Texture

Soils vary from extremely coarse to fine. Sand is coarse and clay is considered fine. Students will use a soil auger and collect samples from a number of sites. Comparisons will be made at the surface and at a distance below the surface for each site. While determining texture students will also observe the amount of organic debris at each level and discuss the reasons for the differences.

Soil Color

Color is normally an indicator of organic composition in soil. Black soil is normally high in organic material and as such is productive and fertile. Yellow or gray soils have few organic compounds and frequently are less productive.

Students will examine soil at three or more locations. Tests and observations will be conducted and recorded at each site. Upon completion of this activity students will be more aware of the intricate relationships involved in soil ecology.

Sources
LaMotte Soil Handbook LaMotte Chemical Products Co., Cheston, Md.

Soil Ecology

One hundred thousand years ago the Wisconsin glacial period began scouring away all of the soil and vegetation that was located in what is now northeastern Minnesota. Ten thousand years ago the final sheet of ice melted and new soil began to form on the bare rock surfaces. When the soil became deep enough, plants began to grow. The information contained on this page, when combined with the results of tests to determine pH, temperature, percolation rates, soil color and organic content; will provide answers to questions dealing with how soil develops.

Record the information required for each of the study sites.

Site	pH	Temp	Perc/rate	% Organic	Texture	Color	Growth	Age
Mixed Deciduous-Coniferous								
Open Disturbed								
Pine Community								
Black Spruce - Tamarack								
Mature Deciduous								

*Growth: Rate each site "1, 2, 3," etc. with "1" being that which seems to promote the greatest growth potential.

*Age: Rate each site with 1 being the youngest soil and 5 the oldest.

Examples of Plants in pH Range

1 -4.0. .	Too acidic for most
4.0- 5.0. .	Blueberries, ferns, spruce
5.0- 6.0. .	Pines, fir, spruce, birch and willow
6.0- 8.0. .	Marsh marigold, ash, elm
8.0-14 . .	Too alkaline for most

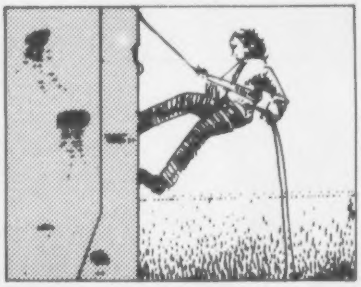
Soil Temperatures

Less than 40°	No growth - bacteria and fungi not very active.
40° to 65°	Some growth
65° to 70°	Fastest growth
70° to 75°	Some growth
Above 85°	No growth

Relationship of Color to Organic Content, Erosion Potential, Aeration and Fertility

	DARK (Dark gray, brown to black)	MODERATELY DARK (Brown to yellow brown)	LIGHT (Pale brown to yellow)
Organic Material	Excellent	Good	Low
Erosion potential	Low	Medium	High
Aeration	Excellent	Good	Low
Fertility	Excellent	Good	Low

Beginning Rock Climbing



Rock climbing is adventure. It provides the development of natural skills and enables learners to fulfill an almost instinctive desire to accept a personal challenge. Climbing is a very important component of environmental education in that it requires the participant to confront both the personal challenge of the climb and the relationship of the climber to the natural environment.

In beginning rock climbing students will learn about climbing equipment, climbing communications, knots, belaying and climbing.

Equipment

The CLIMBING ROPE is the climber's lifeline. There are two major types of rope, braided and kernmantle. Braided rope looks like normal braided rope and kernmantle is rope that has an inner core of braided or twisted cope covered by a braided sheath. The kernmantle rope has less stretch than the braided. CARABINERS are oval metal rings with a "gate" allowing the attachment of another carabiner or the insertion of a rope. The major use of carabiners is to attach ropes to points and to serve as a rope guide. NYLON WEBBING, normally one inch wide, is made of continuous strands of nylon and is tubular. Webbing is easy to tie and is used to make anchors and to tie climbing and rappelling slings.

Communications

It is absolutely essential that students understand communications. The following terms have become universal in climbing and beginning climbers will be required to memorize their meanings.

ON BELAY	The climber's indication that he is tied into the rope.
BELAY ON	The belayer's response to the climber's "on belay".
CLIMBING	The climber's indication that he is ready to climb.
CLIMB	The belayer's response that the climber may start climbing.
TENSION	The climber's instruction to the belayer to tighten up the rope.
FALLING	The climber's signal to the belayer that he is about to fall.
SLACK	The climber's indication that he needs more rope from the belayer.
OFF BELAY	The climber's signal that he no longer needs the belayer.
BELAY OFF	The belayer's signal that he is no longer holding the rope.

Knots

Before beginning to climb it is essential that climbers know how to tie a bowline (bo-lin), the most important climbing knot. Students will be instructed in both the tying of the knot and its uses. Other frequently used knots important to the beginning climber are the double bowline, the half hitch and the figure eight knot.

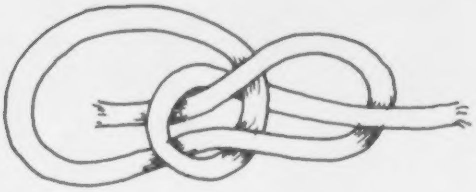
Belaying
Students will be taught the method of belaying which is the act of keeping the climber's rope tight enough so that if he falls he will not fall far and yet loose enough so that the climber has considerable mobility. At this time the students will be instructed in the use of webbing.

Climbing
Students will experience a three point climb, a chimney climb and a lay-back climb, with the opportunity to develop a degree of skill for each.

Sources

Basic Rockcraft	Royal Robbins
Ropes, Knots and Slings for Climbers	Walt Wheelock

Bowline Knot



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Animal Signs

To the casual observer the forest presents little indication of animal life. For the careful observer, evidence abounds. Plants may offer evidence of yesterday's diner as well as last year's. Mountain maple with growth restricted to three or four feet and with tops shredded off tell that the white tail deer frequently have visited, not just recently, but likely last year, too. A giant old fire-scarred white pine will provide evidence not only of past fires but also of current and past use by birds, insects and mammals. Looking carefully to the ground reveals not only tracks but territory markers, homes and often shed parts of animals. There is much to be learned by a careful and planned examination of the forest.

Following a short classroom synopsis of tracks, feeding marks, droppings, homes and territories, students will be taken into the forest and, often using keys, sharpen their observation skills.

Tracks

Using a key students will examine and learn to differentiate between animals that HOP and those that AMBLE. There are three types of hoppers. The snowshoe hare and others leave a track that has the front feet side by side and the hind feet side by side with the hind feet tracks in front of the front feet. This is caused by the momentum of fast movement and is not true when the animals are moving slowly. The second type of hopper are those whose front and rear tracks are also side by side but whose rear feet do not set down in front of the front feet while running. Mice are a good example. The third hopper is the trailing foot hopper and all of the weasel family demonstrate this trait.

Feeding Marks

Using keys, students will examine and learn to identify eat marks. Snowshoe hares, grouse and deer all nibble twigs, but each in its own way. A number of animals chew or gnaw on bark and wood. Recognizing the location of the chew mark and the type of wood normally provides adequate evidence to determine the type of animal responsible. Downy woodpeckers dig small round food holes, hairys dig small oval holes and the pileated, the forest's largest woodpecker, digs the largest woodpecker hole. Carpenter ants leave sawdust at the base of a standing dead tree and bark beetles chew galleries just under the bark. Predators often leave not only their tracks but also parts of their kill, such as the feet, beaks, feathers or antlers of their prey.

Scats

Students will examine scats (droppings) of common wild animals and attempt to learn something of their food preferences. Deer have soft summer scats which are the result of eating soft green food, and in the winter months, their scats are hard oval pellets representing their winter diets. Hares can eat their own droppings in times of low food supply. Grouse usually leave piles of scats on drumming logs where they spend much time announcing territory rights and attracting mates. Owl pellets are regurgitated bones and hair and often are found at the base of an owl's favorite tree. Mink, otter and fisher scats are frequently found along river and lake shores.

Homes

Frequently animal homes are moved often and not easily observed. Students will learn about animal behavior as it affects their selection of resting and sleeping places as well as examine the homes that are observable. Procupines roost inside a convenient hollow tree and grouse roost in a tree during the summer or a convenient snowbank during the winter.

Territory

Students will learn why animals establish territories and search for animal territory markers. The whitetail buck rubs trees and scrapes the ground to identify his area as compared with his neighbor's; the beaver uses scent mounds and the wolf uses scent posts.

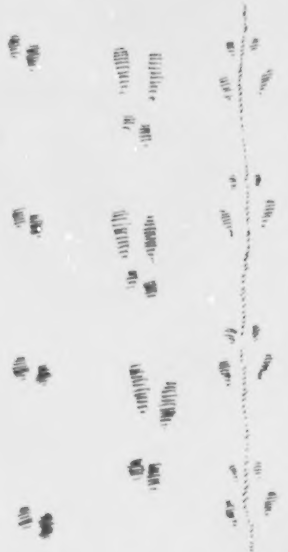
Sources

Field Guide to Animal Tracks	Murie
Field Guide to Birds	Peterson

Glossary

Rodent	Mammal characterized by large upper and lower incisors (buck teeth) with the exception of the rabbit family
Mammal	Animal with hair, born alive and having mammary glands
Stride	Distance an animal strides while walking or running measured from track to track of the same foot.
Straddle	Distance (width) between right and left feet.
Browse	Twigs and buds eaten by animals
Gall	Abnormal growth in plant caused by secretion of an insect
Roost	Sleeping area, usually in a tree
Pellet	Regurgitated bones and hair from birds of prey

Hopping Tracks



Weasel Trailing Foot

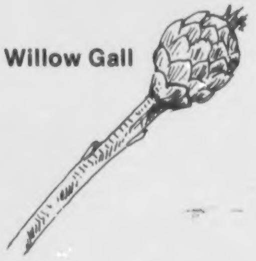
Hare Overjump

Mouse Side by Side

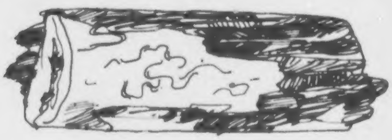
Ambling Tracks

Man

Willow Gall



Bark Beetle Galleries [Burrows]



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Aquatic Animal Behavior

The frog sits motionless, eyes peering just above the surface. Its lack of response makes the viewer move closer. Suddenly the reason for its behavior becomes vividly clear. The frog is dead! A three inch giant water bug, disturbed from its meal, moves slowly from beneath the frog to the bottom mud and disappears. Nearby an equally grotesque creature climbs up a cattail and settles. Within the hour its back will split, revealing a dragonfly which pumps its wing veins full of fluid and flies off, pursuing mosquitos. In winter, through the clear window of new lake ice, a predacious diving beetle may be seen visiting an air bubble. The beetle will take a "footfull" of air with its hairy hind legs and carry this air supply down into the water as it hunts. The world of aquatic animals is complex indeed.

Students will learn to identify a number of aquatic insects, worms and minnows, with special attention paid to each animal's habitat and the relationships within the habitat.

Identification

Following a classroom presentation explaining the life cycle of insects, students will go to the river or lake and attempt to capture a number of aquatic animals. Depending upon the season, the naiad of caddis fly; dragon fly, stone fly, may fly and damsel fly will be "keyed out". Water striders, water boatman, scuds and predacious diving beetles as well as segmented arthropods, leeches and a variety of minnows are also liable to be captured and studied. Mayflies spend about 24 hours as an adult, living only long enough to breed and lay eggs. Giant water bugs must be handled with care, as their venemous bite can cause painful swelling.

Habitat

Students will be asked to generalize about the habitat of each captured animal. Tests will be taken to determine the factors important to the habitat: dissolved oxygen, temperature and pH. Dissolved oxygen is a measurement of the amount of oxygen available to the animal. Temperature is important in that it directly affects the available dissolved oxygen. pH is a method of measuring one quality of a water environment with 7 on the pH scale considered ideal for most animals. The pH scale is a continuum from 1, which is acid, to 14, which is base. For this purpose it is important to understand that a pH near 7 is most ideal for most animals. Few are able to survive if the pH is near either extreme. Water velocity, bottom composition, vegetation types, depth and clarity will also be considered.

Behavior

Students will conduct a few simple experiments to determine some of the instinctive behaviors of aquatic animals. Free swimming scuds are attracted to light while bottom animals prefer dark environments. Diving beetles prefer random motion in open water so they exhibit negative geotaxis or movement away from the pull of gravity. Bottoms with texture are preferred by slow moving animals and rapid swimmers will be found near a variety of bottom textures. Prey-seeking behavior is usually such that free swimming animals are fast and bottom crawling animals are stealthy.

Sources

Freshwater Biology	Needham and Needham
Pond Life	Golden Guide Series
Animal Behavior	Alcock

Glossary

Substrate	bottom of a lake or a stream
Phototaxis	movement toward strong light
Geotaxis	movement in direction of gravity pull
Pelagic	free swimming, not near bottom
Nymph stage	water insects that will eventually become an adult and live in the same water environment
Naiad stage	water insect that will next become an adult living in a non-water environment

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Beaver

Animals have social behavior patterns that help them to survive. Beavers are no exception, however, most of their social behavior seems to happen inside the lodge during the day. At night, beavers seem to have little to do with one another, industriously working alone. Subtle communication does occur between beavers, such as warning tail slaps on the water. The adult female seems to be the dominant member of the family.

After an indoor session on beaver social behavior, students will examine signs of activity and sources of food on nearby lakes. They will also visit an active beaver lodge.

Social Behavior

Beaver social behaviors have been studied very little. The female, often seeming most dominant, sets up territories, does most dam and lodge maintenance, builds most scent mounds, emerges from the lodge first at night and has more effective tail slaps.

Young beavers stay with the parents for two years, so there are usually three age classes of beavers in a family. After eviction, the two-year-old beavers travel upstream or to a new watershed to establish a territory. Their parents, using scent mounds, establish their territory to prevent the two-year-olds from returning.

Food Preferences

Students will examine food sources and determine beaver food preferences. During the summer primarily aquatic plants will be examined. During the fall, winter and spring the food cache will be examined.

Signs

Signs of beaver activity which indicate the presence of beaver will be located. These signs will include cuttings, dams, lodges, drags, canals, droppings, sounds, scent mounds, and often the beaver itself.

Adaptions

By examining a beaver skin, skulls, tail and feet, students will become more aware of ways in which the beaver has adapted to living in the water. The tail is used for support in the water and on land, for steering and to communicate danger. Feet are adapted to walking and swimming as well as doing mud-work in dam and lodge construction. The teeth grow constantly, wear differently and remain always sharp. The beaver's fur is oily, with guard hairs and soft underfur providing warmth. Other specialized adaptations include flaps over the mouth, ears and nose enabling the beaver to stay under water longer.

Sources

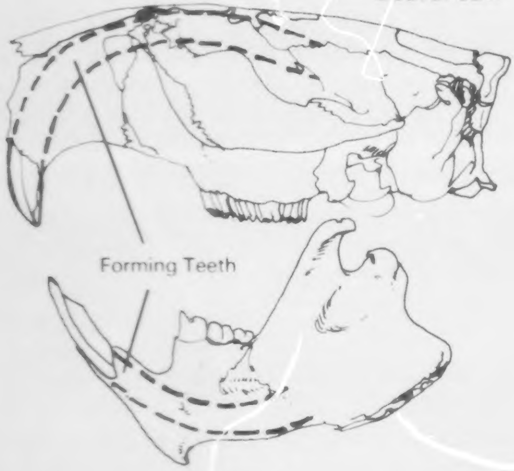
My Beaver Colony	Lars Willson
Beaver in Minnesota	Bill Longley

Glossary

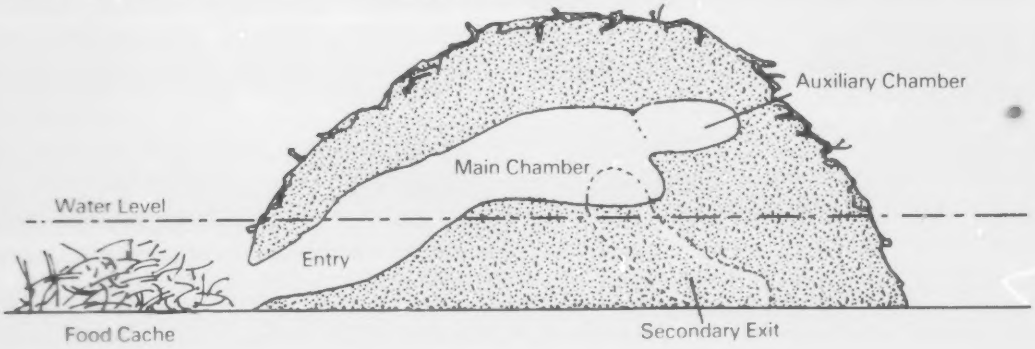
Social Behavior	Behavior taking place between two or more animals
Dominance	Control or power over other animals.

Scent Mound	A pile of mud and sticks on which beavers or other animals secrete an identifying scent.
Dispersal	The movement of young animals to a new location.
Cuttings	For the beaver, felled trees or half eaten food.
Drag	Marks resulting from the movement of trees and shrubs to the water.
Food Cache	Stored food. For the beaver the cache is the winter food supply. Aspen, birch, willow, alder and mountain maple are the preferred foods used in constructing a food cache.
Castorium	An oily, anise (licorice) smelling substance which is found in castor glands that are located on the lower abdomen of all beavers and used for marking territories.
Nictitating membrane	A clear third eyelid which enables beaver to see underwater.

Beaver Jaw



Beaver Lodge



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Basic Survival

Survival kits come in a variety of forms and with an even greater variety of parts. Fortunately, the basic needs of shelter, food and warmth are available in most wilderness areas without a kit. All that is required is an understanding of the methods used by the Ojibwa Indians to deal with the basic needs.

Beginning with a classroom presentation students will increase their understanding of how to provide shelter, food and warmth in a woodland setting, without a survival kit.

Shelter

Protection from the elements is the main purpose for erecting a shelter, be it a tent or an Indian-like shelter constructed of evergreen boughs and saplings. Selecting the shelter site with consideration given to ground water run-off and protection from the wind is important. The actual shelter, when constructed of natural materials, should be no larger than is needed to provide protection in order to conserve energy during construction. Students will be shown a variety of methods used by the Ojibwa Indians to construct adequate shelters.

Food

Survival frequently requires the ability to eat unfamiliar and often unpleasant food stuffs. Edible plants normally abound during the non-snow season and students will be introduced to a number that can be used to survive. Throughout the winter the major source of plant foods available are the lichen **usnia**, known to many as "Old-mans-beard", and the inner bark of white pine and paper birch trees. Insects are available in summer and winter and are especially important as they are high in fat, the most important body need during the winter. Students will also be shown how to prepare a small mammal snare using cedar bark.

Warmth

Students will learn how to make maximum use of their own bodies as heat producers, how to start a fire without matches, and how to recognize and deal with hypothermia.

The proper insulation placed around the human body will slow the normal function of letting off heat and result in the body staying warm even if the air temperature is quite cold. Layers of clothing do not by themselves add heat, however, they do slow down heat loss and keep the body warm. The purpose of layers is to restrict the movement of the heated molecules away from the body. It takes a single heat-carrying molecule four times longer to go through four layers of a material than it takes it to go through one layer of the same material. Remembering that the body, if busy, is always producing and generating heat correctly suggests that with the proper clothing it is even possible to be TOO WARM even if the temperature is well below zero. Thus another benefit of layering is that clothing can be removed to cool off. Heat is removed from the body more quickly if the moledules located near the body are close together. A layer of wool, with its loosely joined molecules and the associated air spaces, will permit less heat loss than a layer of tightly woven cotton. Molecules of water, being closer than those in any cloth, will result in very rapid heat loss and thus it is important to stay dry. This loss of body heat is called convection and the varying rates of loss depend upon the molecular structure of the medium (wool, cotton, water and air for example) through which the heat has to pass. Wind can expedite the movement of warm air in spite of the layers and for that reason it is often important to wear a wind-breaker on the outside of the layers of clothing.

Hypothermia results when the body is cooled at a rapid rate resulting in the body core becoming so cold that it ceases to function properly. There are six "signals" with the first one being the most important because recognition of the first signal can prevent the remaining five. If a body enters the second phase it is then necessary for another person to recognize the problem and take steps to prevent the potential death of the afflicted person. Students will learn the six signs of hypothermia and how to deal with them.

Working in teams students will use a primitive bow-type fire builder and attempt to kindle a fire. They will have the opportunity to learn how to construct a fire builder.

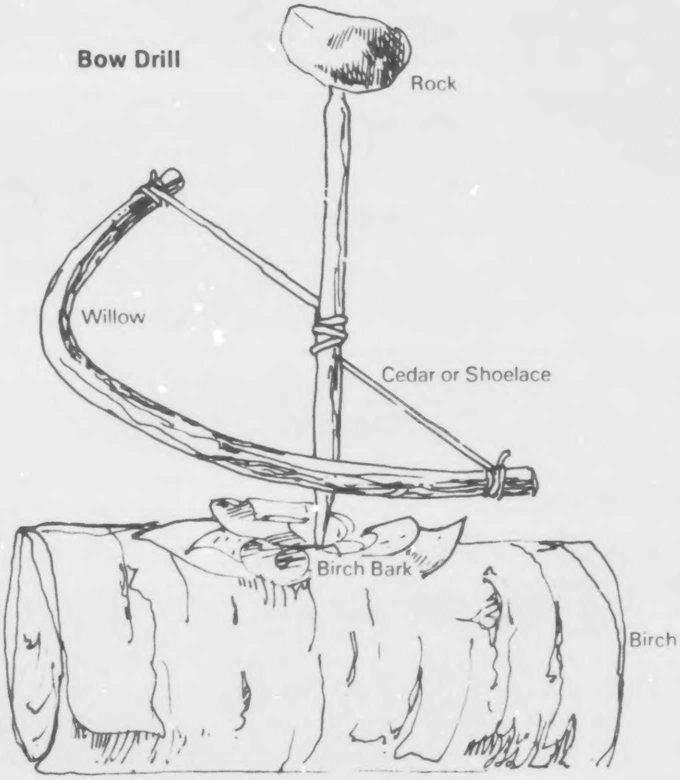
Sources

Outdoor Survival	Larry Dean Olson
At Home in the Woods	Bradford Angier

Glossary

Conduction	The passage of heat through molecules which are close together
Convection	The passage of heat through molecules which are far apart
Dead Air	Small isolated air spaces containing trapped air (as in a wool cloth)
Hypothermia	Lowering of the body core temperature (exposure)

Bow Drill



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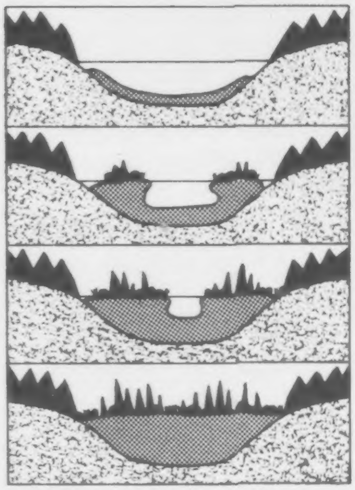
Bog Succession



Ten thousand years ago Northeastern Minnesota was covered with a vast sheet of moving ice. In most places, the glacier ice was thousands of feet thick. In time the ice melted and left behind the "Land of 10,000 Lakes". In fact, the captured melt water left many more than ten thousand bodies of water ranging in size from the world's largest freshwater lake to countless small impoundments. Some lakes became a part of natural drainage systems. Others did not and they were destined to become bogs.

Bogs are typically surrounded by a narrow, moat-like trough of shallow water. Black spruce trees frequently grow on the edges of bogs. Moss and Labrador tea join to provide a spongy cushion-like carpet upon which the hiker bounces along. Toward the center of the bog the black spruce thins and is replaced by infrequent tamarack, the deciduous conifer. Careful examination of the bog floor will possible reveal not one or two, but three meat-eating plants. The bog is indeed an unusual habitat.

Following a short indoor introduction to glacial geology and bog succession, students will go to a bog and (1) identify a number of plants, (2) observe the fen, and (3) do a pH test, relating the acidity to bog conditions.

Geologic History

The scouring continental glaciers picked up and carried heavy loads of debris. Small pebble-sized rocks and huge boulders, as well as living plants and animals, were captured and carried by the Pleistocene ice sheets. When the climate changed and the ice melted, the transported materials, called till, were set in place. The melt-water filled small and large depressions creating countless lakes. Those lakes that were isolated and did not become a part of a drainage system were denied water-borne mineral nutrients essential to certain kinds of decay-causing bacteria, especially those kinds which decay plants. Without those bacteria, plants in the small bodies of water died, and rather than decay, dropped to the bottom. In time, the layers of dead plant material became deeper and deeper, eventually forming a bog. Some bogs have dead plant layers forty feet thick, representing thousands of years of bog succession.

Bog Plant Adaptations

Bog plants must adapt to the low nutrient level in bogs as well as the acidic soils created by some of their neighbor plants. Because of the low nutrient level, most bog plants grow very slowly. A two-inch diameter black spruce can be nearly one hundred years old. The plants of the blueberry family secrete humic acids into the soil, eliminating many competitors. Some plants have adapted to the low nutrient level by eating meat! Pitcher plant, sundew and bladderwort are insectivorous plants. Bog plants have heavy leathery leaves that drop directly under the plant they grow on, thereby recycling their nutrients back to the bog.

Bog Succession

As a lake fills in, the younger portion of the bog mat is the leading edge near the water. The oldest portion is near the high land, where the bog first started to fill in. Certain plants are characteristic of the stages of bog succession. The leading edge contains sundew, sedges and bog bean. The open area behind contains pitcher plant, bog rosemary and bog laurel. The tamarack area contains leather leaf, and the black spruce area contains Labrador tea and snowberry. The nutrients which do wash into the bog from slopes are caught on the outside edges. This enables a small amount of plant decay to occur there, and the resulting shallow trough of water is called a "fen".

Glossary

Bog An area of plant buildup in a former lake, characterized by the presence of certain acid-tolerant plants.

Moraine Uneven terrain, usually hilly, caused by direct deposition of glacial materials.

Till A term used to describe the unsorted materials left by the melting glaciers. Till consists of material ranging in size from grains of sand to house sized boulders.

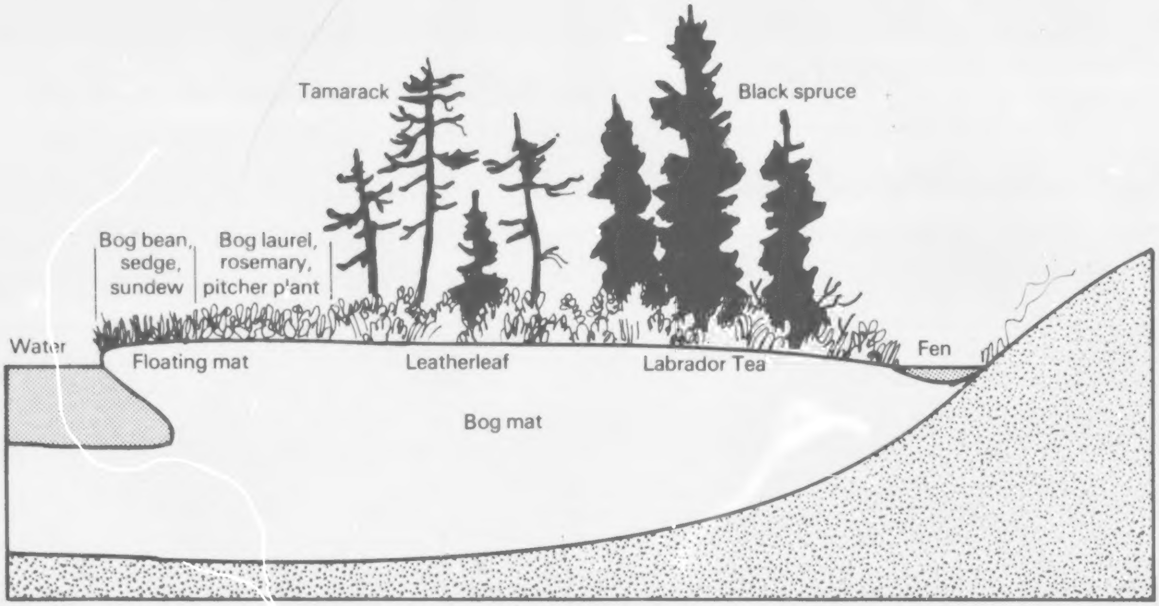
Watershed The area of land drained of rainfall by a certain lake or stream system. The Lake Superior watershed consists of all of the land around the lake that drains into the lake.

Succession The predictable sequence of changes in the plant species that inhabit an area. Succession will result in bare land eventually becoming grassland or forest; at a certain point, the vegetation becomes stable and is called the climax stage. Lakes also undergo a series of changes; they become ponds, marshes and eventually dry land. If they are without a large watershed and in northern areas, they become bogs and eventually dry land.

pH A test whereby the acidity of a given substance may be determined.

Sources

Field Biology and Ecology Smith



A "Bog Lake" Indicating Bog Succession

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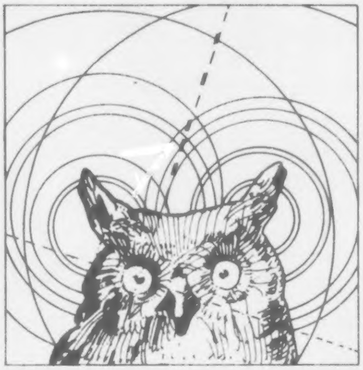
Animal Senses



An owl can catch a mouse on the darkest of nights, using sound alone. Hunters have amazing tales of deer detecting them by smell at distances of half a mile. Fish can taste their way back to the creek in which they hatched from thousands of miles away. Snakes can feel the approach of other animals through the ground. Animal senses have been specialized and tuned by evolution over millions of years. Their survival is directly affected by taste, smell, sight, sound and touch. Some scientists have even shown evidences of such sixth senses as a bird's ability to navigate by the earth's magnetic field. Some animals can even forecast weather!

Using games which simulate the senses of animals, students will learn the variety and complexity of those senses.

Sound

Deer, hares, and wolves have movable ears to pinpoint sounds. They usually reinforce a potentially dangerous sound by looking in the direction from which it came. Owls have asymmetrical ears (one ear faces backward) which receive the same sound at DIFFERENT times. This enables the owl to triangulate to the exact location of the sound. Blind owls can still catch mice, provided they don't fly into a tree between themselves and the prey. Generally, the larger-eared animals hear better and depend on sound for their survival.

Smell

Humans have one of the poorest noses of all animals. It usually takes a skunk to get our attention! Other mammals use smell to a tremendous degree. Deer follow each other's trails, communicate danger, and mate by complex scent systems. Bears rub against a tree to mark their territory, and another bear can smell the tree a week later and tell the mood of the marking bear! Scents drift upward and with the wind, and many hunters use this information wisely by sitting high in a tree downwind from the prey. Longer noses with complex nasal passages generally make an animal able to detect scent more effectively. Snakes of certain kinds can detect body heat a few yards away! Mosquitos can smell carbon dioxide (which animals breathe out) and zero-in on the victim.

Sight

Most mammals are color-blind and some are nearsighted. Their ability to see motion is critical, for that can mean danger. Deer will walk within fifteen feet of a motionless person, but flee at the turn of a head five hundred feet away. They also don't look skyward very often, for few birds of prey can carry away a deer! Animals such as wolves and owls, which must locate prey at a distance, have their eyes located on the front of their heads. This enables them to triangulate using both eyes, and estimate distance accurately. Hares, mice, squirrels, and small birds have eyes located on the sides of their heads, an advantage in seeing potential predators from every direction. Nocturnal animals, such as flying squirrels and mice, have large eyes for gathering more light. The absence of color-receiving cells in the eye is an advantage to night-active animals.

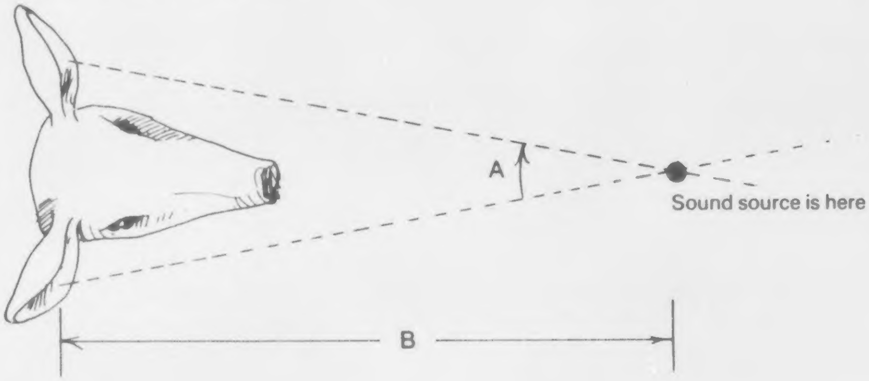
Sources

The Secret Life of Animals	Milne
Animal Behavior	Alcock

Glossary

Acuity	Keenness, sensitivity of a sense
Adaptation	Change to fit surroundings
Triangulation	Pinpointing a spot by using the intersection of two lines or directions
Olfactory	Having to do with the sense of smell
Peripheral Vision	Vision to the side while looking ahead

Sound Location by Triangulation



Angle (A) determines distance (B)

The Field Community

Fields in a northern boreal forest are most often the result of a disturbance. If permitted to return to its natural growth system, the field will, in time, become part of the surrounding forest.

In the late summer northern fields are alive with brown-eyed susans, hawkweed and grasshoppers. Grass eating meadow voles and grasshoppers, with shrews trying to eat them may be seen hurrying around, through and under the mat of dead plant materials carpeting the ground. Small forest mammals are often difficult to see, but here in the field careful observation frequently results in successful sightings.

Flowering composites become more numerous toward the edge of the field. The grasses, which are thick in natural grassland areas, are sparse and almost non-existent on the outer edge of a field in the northern biome. At the field edge daisies and hawkweed make way for dogwood, hazel, willow and other shrubs. Aspen and birch become more apparent and upon entering the forest, shrubs and forbs completely disappear. A walk from the center of the field to the edge of the forest is a walk through time.

Using a key to field plants, students will identify plants and be able to construct a model of plant succession after interruptions. The concept of biomass and its relationship to sunlight will be introduced by the Naturalist.

Identification
Field flowers seem to bloom best from mid- to late summer. "Weeds" such as orange hawkweed, daisies, and black-eyed susans perform an important function in adding organic nutrients to bare soils in waste places. Clovers add valuable nitrates by attracting and harboring "nitrifying" bacteria in their root systems. Yarrow and goldenrod have medicinal uses, as do heal-all and pinappleweed. Blooming times overlap, but peaks of blooming are definitely staggered throughout the summer. In this way, species do not compete with each other for pollinating bees.

Succession
Walking from the center of a field toward the forest, the plants will get taller, the soil will become moister due to buildup of organic debris, and the ground will become more shaded. The arrangement of animals and plants will become, by necessity, more vertical. It might seem that field succession would result in the same plant arrangement at every location, but this is far from the truth. A number of variations in the plants prevent this from happening. For example, aspens and birches grow very quickly because of their "suckering" root systems. Fields that are adjacent to aspen and birch stands will skip some of the primary succession plants. Drainage, slope direction and soil types are other variables that profoundly affect field succession.

Biomass and Energy Recycling
The amount of sunlight that falls on a field and its neighboring forest is nearly the same. The sun's energy is gathered by green plants and stored as food. This stored energy is shared with other plants and animals by the processes of predation, parasitism, death and decay. Through soil-making processes the sun's energy is recycled back into the plants. Because of the storage capacity of soil, there is more biomass in the later stages of succession (the forest). Since the field's biomass is

entirely in one layer on the ground, there are more plants and animals in the field than on the forest floor.

Sources

Field Biology and Ecology	Smith
Ecology	Odum
Flora of Northeastern Minnesota	Lakela

Glossary

Succession is the gradual replacement of one group of plant species by other plant species.

Biomass is the total living and non-living organic material in a given area.

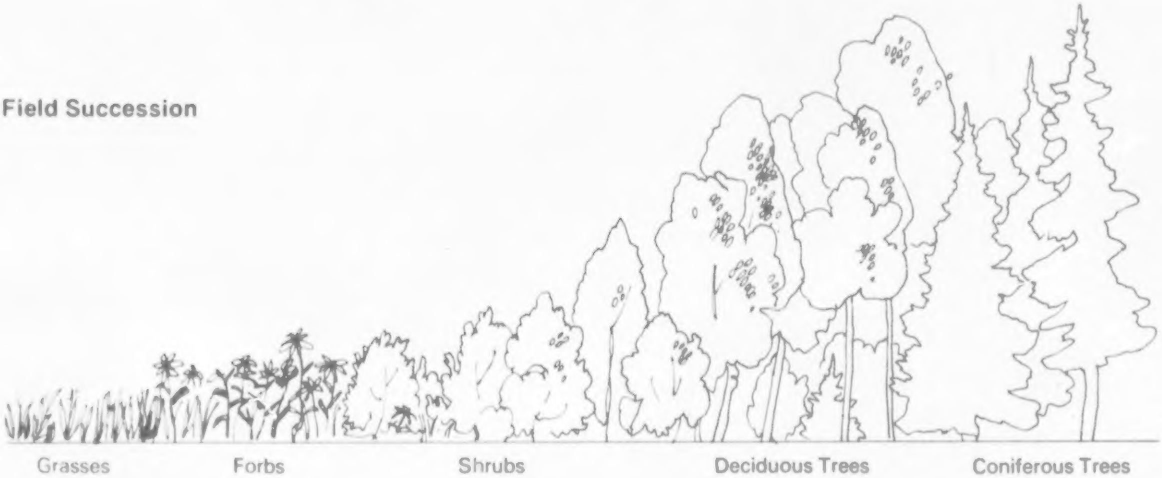
Community is an assemblage of certain plant types which are characteristic of an area.

Suckering results when the main stems of aspen trees are cut. The roots continue to absorb nutrients and this "rush" of nutrients triggers a chemical reaction which causes small nodules growing on the roots to become new stems which use the nutrients. In some cases the growth is very vigorous and the sprouts achieve heights of up to eight feet in a single growing season.

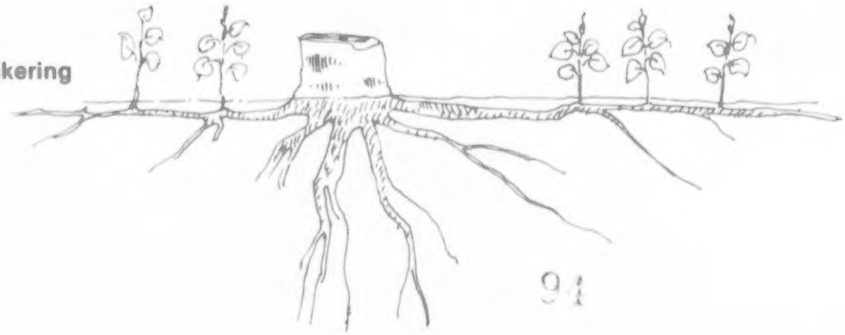
Forbs are non-grass field plants with shallow root systems and composite flowers. Grasses and forbs are both herbaceous plants.

Herbaceous plants are those that do not have woody stems and do produce seeds.

Field Succession



Aspen Suckering



Geology

The Northwoods is a maze of gravel, mud, hills, bogs and rock, all covered with lush greenness. Bogs have specific plant types that can live in the acid, sterile waters typical of bogs. Gravel hills are occupied by jack pine and other plants which prefer dry, well-drained soils. Rocks, be they random glacial erratics scattered by the scouring Pleistocene ice or the massive volcanic palisades, will harbor crusty, flattened lichens that are perhaps thousands of years old. Woodsia ferns and an occasional wintergreen plant, will, with the lichens, begin the extremely slow process of changing the rocks to sand. Poorly drained areas may sprout hundreds of gnarled aspen and black ash trees. Plants are a living lesson in geology, but only by careful observation can the relationships be discovered.

Following a blackboard story of the geological history of Northern Minnesota, students will walk to areas which illustrate various glacial landscapes. They will examine soil and rock types, determine how soils originated, and identify indicator plants.

Bedrock Geology
There are three "families" of rocks. Igneous (fire rock) rocks form from melted magma deep beneath the earth's surface. Large crystals form during slow cooling at great depth while small to microscopic crystals form during rapid cooling on or near the surface. Sedimentary rocks are often layered and frequently contain fossils. These rocks are the result of deposition of eroded materials. Metamorphic (changed rock) are either igneous or sedimentary rock that have been changed inside the earth by the application of great heat or pressure. Minnesota contains some of the oldest rocks on earth, some over 2.7 billion years old!

The Duluth gabbro is a large intrusive igneous formation that underlies much of Northeastern Minnesota. The Ely Greenstone (which is green) is a volcanic extrusive that was metamorphosed about 2.7 million years ago.

Glacial Geology
One million years ago the climate of the earth had cooled enough so that all of winter's snow did not melt each summer. Within a short few hundred years the accumulated snow had reached depths of thousands of feet and, due to the force of gravity and the earth's shape, began to move. The Pleistocene Ice Age began a million years ago and some scientists say it hasn't ended yet. Four times the great ice sheets advanced and retreated, with the last retreat just ten thousand years ago!

Glaciers in Northern Minnesota were as much as 2 miles thick during the four advances. Summer still melted part of the snow and ice and the meltwater seeped into cracks of underlying rock. Winter's cold temperatures froze the water, expanding and breaking the rocks. These assorted pieces of rock were carried, and scoured into sand and dirt by the ice. When the climate changed again the ice melted and all of the glacier's "load" was dropped. This load created moraines, pot hole lakes, gravel beds, and in general a landscape conducive to lakes, bogs, swamps, gravel hills and rocks.

Plant Geography
Most plants have specific requirements of water, nutrients, sunlight and soil acidity. Plants on north slopes of hills generally need less sunlight. Cedar, spruce and pyrolas can be found in great

abundance on north slopes. Well drained areas of glacial outwash are usually populated by pines, wintergreens, and trailing arbutus, all of which are able to use and store water quickly, before it passes down through the soil to the water table. Ash, poplars, and sedges are usually found in poorly drained areas because they can tolerate standing water and periodic floods. On the ridges above the lowlands (but still on the till) will be birch, white spruce and balsam fir. Bogs are formed in areas with poor drainage and low nutrient levels. Without nutrients, bacteria cannot break down plants that die, and the bog soon fills in. Bare rock is so well drained that most of the plants, such as lichens, soak up rain before it evaporates.

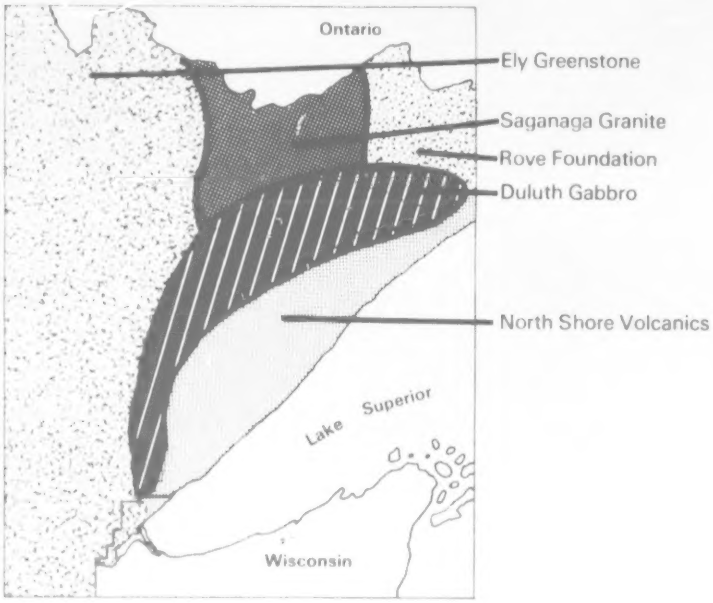
Sources

Ecology and Field Biology	Smith
North America and the Great Ice Age	Matsch
Geology of Minnesota: A Centennial Volume	Minnesota Geological Survey

Glossary

Till is an unsorted glacial sediment with random sized particles.
Outwash is a sorted glacial sediment deposited by running water.
Igneous are rocks formed from magma.
Metamorphic are rocks formed by heat and pressure without remelting.
Sedimentary are rocks formed by mechanical action of water, wind or ice.
Extrusive are igneous rocks which came to the surface as volcanic flows.
Intrusive are igneous rocks which hardened well below the surface.

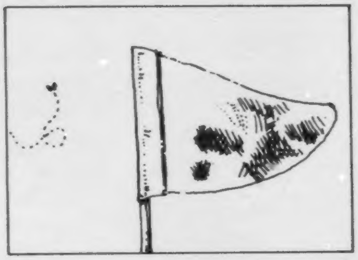
Bedrock of Northeastern Minnesota



Northeastern Minnesota Igneous Rocks

Texture	Low Iron	High Iron
Fine grained	Rhyolite	Basalt
Coarse grained	Granite	Gabbro

Insect Ecology



As you walk through a summer field there is constant commotion near your pantlegs. Grasshoppers, leafhoppers and katydids scramble to get out of your way. Some days there seem to be millions. Entering the shade of the forest, you are suddenly surrounded by a hoard of mosquitoes. Now you know. There are millions! It is very apparent that certain insects prefer moist shady situations and others like to be in the sun. Some live in soil, others under tree bark and some can live inside of a single leaf! Habitats for insects are extremely specialized.

Using a mark-recapture population sampling technique, students will learn how insects cope with survival problems by high reproductive rates, and how specialization has led to long dormancy periods and very specific micro-habitats for most insects.

Identification

Insects have a few things in common. All are cold-blooded and all have an exoskeleton, a hard outer covering with muscles attached inside. Insects have six legs and body parts consisting of a head, thorax and abdomen. Grasshopper family members (crickets, katydids) have large rear legs for springing. Beetles have large chewing mouthparts and hard covers over their wings. True "bugs" (cicadas, leafhoppers) have sucking mouthparts. Flies (mosquitoes, blackflies) have only one pair of wings. Bees (including ants) have constricted connections between the thorax and abdomen. Dragonflies and damselflies have extra long abdomens and are predacious hovering fliers.

Habitat and Niche

Insects are dwellers of very specific habitats. Bark beetles live in galleries (tunnel systems) under tree bark. Different species of beetles use the bark of different species of trees. Spruce budworms live only on spruce and balsam firs. Grasshoppers live mostly in the lower grasses of fields, but katydids are found on the upper blades. Of the thousand or so mosquito types, some are specific to bogs, some to lakes and others to temporary ponds. Some mosquitoes lay eggs on a five-year flood-plain and only hatch during a flood. A certain kind of mosquito lays its eggs only in bog pitcher plants, which normally eat mosquitoes! Only a few kinds of mosquitoes have human bloodsucking as their job, or niche. Some are specific to birds or don't drink blood at all. Many wasps are parasitic, laying their eggs on or in the larvae of some other insect. The ichneumon fly with its three-inch-long ovipositor (egg-laying tube like a hypodermic needle) is one of these.

Population Dynamics

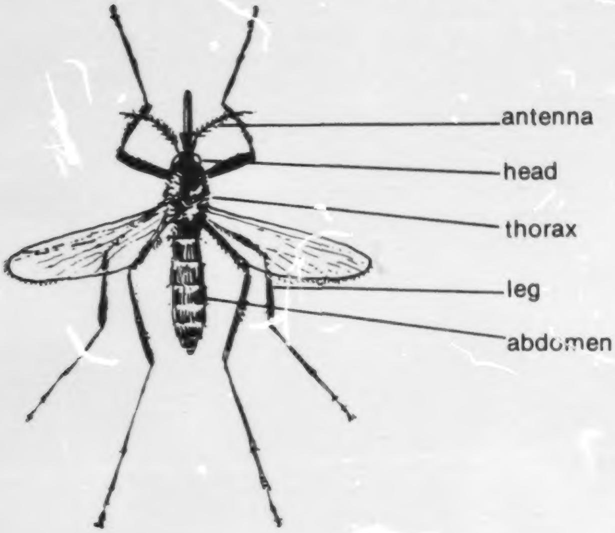
There are about a million species of insects, more or less, and the actual numbers produced each year is beyond human comprehension. If they all lived, it would be a matter of days before the entire earth was overrun. Why doesn't it happen? As luck would have it, insects eat mostly each other. They are also food for countless fish, reptiles, birds and mammals. Some have extremely short life-spans, living less than a day as an adult.

Insects such as mosquitoes and blackflies number in the millions at times, but in the fall and winter, they are nowhere to be found. They must deal with survival by sheer numbers, as just a tiny fraction of them find a meal and reproduce. Some insects can share the same habitat and niche, but only because they hatch at different times. Their population "peaks" come at different times. Just when one kind of mosquito quits biting, another starts!

Sources

Insects	Golden Guide Service
A Textbook of Entomology	Ross

Insect Body Parts



Lichens, Ferns and Mosses

Lichens, ferns and mosses are three common non-flowering plants found in northeastern Minnesota. Lichens are actually two different plants, an alga and a fungus which grow together and reproduce new lichens. Mosses grow from spores produced in capsules which, with the addition of moisture, will swell and release a growing green thread. Ferns also reproduce with spores, however the spores grow on the underside of the fern fronds. The kingdom of non-flowering plants consists of more than 350,000 species of plants found all over the earth. They range from tiny microscopic bacteria to the largest trees of all, the redwoods of the Pacific coast. Conifers, which include the redwoods, are technically "non-flowering" plants as are lichens, ferns and mosses.

A directed walk through the northwoods will result in repeated sightings of lichens, ferns and mosses. Long flowing usnia, a lichen commonly referred to as "old man's beard" can be found hanging from the dead lower branches of conifers. Flat, crusty lichens are the first plants to attach themselves to large boulders and rock cliffs, serving as a pioneer species, the first to grow on a very sparse site. These lichens begin the long, slow process of changing the rock to soil and will also serve as the eventual foothold for other plants. Club mosses, like little pines and cedars, send up small spikes containing spores, which may seem, to the first-time observer, like a golden powder.

Students will be introduced to lichens, ferns and mosses. Emphasis in the classroom and on the walk will deal with lichens, the reproduction of non-flowering plants with special emphasis on ferns and mosses, and the identification and lore of a variety of lichens, ferns and mosses.

Lichens

Lichens are actually two different plants, an alga and a fungus. The two plants live together and both benefit from the relationship (symbiosis). The fungus, usually the most conspicuous portion of the plant, supplies the alga with water and minerals. The alga manufactures carbohydrates which may be used by the fungus. This relationship is so successful that lichens can grow on bare rocks and have been known to live for hundreds of years. Some lichens secrete chemicals which break down the rocks upon which they live and use the nutrients from the rock. Usnia is a favorite winter deer food, and lichen dyes produce some of the richest colors available.

Mosses

Mosses grow from spores produced in capsules. They grow just about anyplace but do require moisture to reproduce. A spore, when it falls to a place that is sufficiently moist, will swell and a green filament will begin to grow. The young moss is called a protonema which will eventually produce buds and go through a cycle which results in a capsule on the mature plant from which spores will be dispersed. Sphagnum moss, haircap moss and cushion moss are common.

Ferns

Ferns are vascular plants that reproduce by spores and usually have large flat leaves on a stalk. Common northeastern Minnesota ferns include the cinnamon, woodsia, interrupted, polypody, common bracken, maidenhair, sensitive and ostrich varieties. The fern leaves or fronds unroll from curled fiddleheads, most of which are very tasty when young. Spores are usually produced on the underside of the leaf in tiny capsules (sporangia) that are grouped in clusters (sori). Rock ferns, such as woodsia and polypody, have fibrous rootlike rhizoids which penetrate the smallest cracks and gain a foothold on even an overhanging rock face. Some ferns can grow in the absence of direct sunlight, having adapted to the dark and damp conditions of a dense forest.

Club Mosses

"Ground pine" are low creeping evergreen plants which bear a resemblance to pines, spruces and cedars. Shining club moss, stiff club moss, wolf's claw club moss and tree club moss are common and will be observed. In the late summer the fertile spikes of club mosses contain yellowish spores which the Ojibwa Indians used for first aid. The club moss spores contain natural styptics which stop bleeding instantly and also help heal wounds by inhibiting the growth of bacteria and fungi.

Sources

Ferns and Fern Allies in Minnesota	Tyron
Field Guide to the Ferns	Cobb
Non-Flowering Plants	Golden Nature Guide

Glossary

Symbiosis is a situation in which plants live together and one of the plants benefits from the association.

Mutualism is a symbiotic relationship in which both organisms benefit.

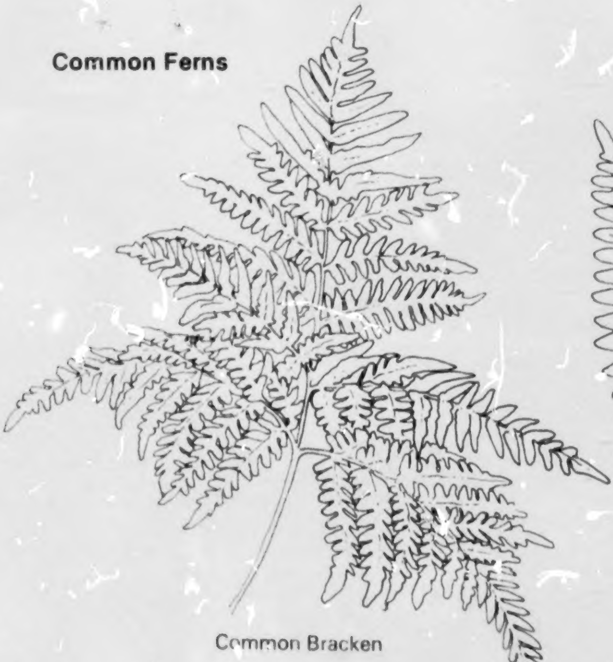
Saprophyte is a plant which lives from dead organic material and doesn't produce its own food.

Alternation of Generations is a reproduction concept of lower plants in which some of the generations have only one half of the normal chromosome members.

Angiosperm and **Gymnosperm** are often considered the seed plants in contrast to the "spore" plants. They differ in the manner of seed development.

Vascular Plants are those which have roots and stems, in contrast to **thallophytes** which lack roots, stems and leaves.

Common Ferns



Common Bracken

Polypody

Ostrich Fern

Plant Medicines

For centuries the most revered members of societies have been persons who understood medicine. The Ojibwa medicine man was called "midiwewin" and held great power because of his knowledge of herbs and their uses. Today over 400 Indian medicines are included among the thousands of synthesized copies of plant medicines that help healing. The increased interest in harvesting wild plants for use has resulted in the return of "home remedies" for a number of illnesses.

Plant medicines can present problems to the would-be modern herbalist. Plants must be properly identified, the useful parts known and recognized and remedy preparation done and administered properly. Mistakes can result in at worst, death, and at best, no result at all.

Students will view a short slide show and use herbal flashcards to associate terms with remedies. A field trip into the forest will in the collection of plants which will be used to prepare a simple home remedy.

Identification
With plant medicine, proper identification can be critical. Wintergreen, strawberry and poison ivy have similar leaf patterns. Wintergreen can be taken as stimulant, strawberry as a diuretic and poison ivy should not be taken at all! Proper identification of plants considers leaf shape, flower shape and color, habitat and closely related species. Remember, whoever first found the poisonous properties of some plants found them the hard way!

Selection
Medicinal and poisonous properties of a plant are not necessarily contained in the entire plant. Different chemicals build up in different parts of the plants and it is important to know which part of a plant contains beneficial ingredients. Rhubarb is a tasty stem and a mild laxative, but its leaves are very poisonous. Potatoes are high in vitamin C, but the leaves, shoots and "eyes" contain solanine, a nerve poison. Chokecherries are tasty, and are used as a medical astringent. However, all cherry stems contain hydrocyanic acid which can, with the proper dosage, kill humans in less than an hour.

Preparation
Medicines have specific purposes and are prepared in specific ways. Marsh marigold leaves are poisonous, but when boiled in three changes of clean water they are tasty and may be used as a mild pain reliever. Some remedies are "not for internal use" as is true of various commercial medicines. Tamarack sap is a soothing skin lotion but poisonous when taken internally. Spores of the club mosses are great for stopping bleeding and healing wounds but will cause sickness if eaten. Most medicines, herbal or otherwise, should only be used under the direction of a physician.

Dosage
Plant medicines demand care and knowledge when used. Dosage is perhaps the most critical, and least understood, of the precautions in using herbal medicines. Most medicines, if taken in excess, can cause death. Dogbane is an emetic (causing vomiting) that will, with the proper dosage, cause death. Tansy cures intestinal worms, but an overdose cures life! There are far too many deadly plants in the woods to experiment carelessly.

Sources

The Herb Book	Lust
Poisonous Plants of the U.S.	Muenscher
The Herbalist	Meyer

Glossary

Emetic - Causes vomiting
Antihelminthic - Cures intestinal worms
Antiseptic - Kills bacteria
Diaphoretic - Causes perspiration
Purgative - Is a violent laxative, causing diarrhea
Cardiac - Will lower blood pressure
Styptic - Stops bleeding
Vulnerary - Speeds healing of wounds
Febrifuge - Lowers fever temperature
Carminative - Relieves intestinal gas
Diuretic - Causes urination

Small Mammals

A broad-winged hawk soars just over the treetops. It tips from side to side in the wind and suddenly drops at the edge of the field. As it flies away something small and furry can be seen in its talons. Later, in a field, careful examination of the matted grasses reveals a small runway with fresh blades of grass piled at the intersections. A meadow vole has left its "food piles" for future use. Further examination uncovers the vole, dead and half-eaten. A shrew apparently used this runway, too. The role of each small mammal in a food chain is different - they can either be predator or prey.

Using livetraps placed in various habitats, students will learn to identify and classify small mammals in the food chain.

Identification

Students will learn to identify the small mammals they capture by using identification books and a special key to northeastern Minnesota mammals. Some of the small mammals have names which are very descriptive. The boreal red-backed vole lives in the boreal forest and has a rust-colored back. The short-tailed shrew has a short tail. The white-footed deer mouse has white feet and is the color of a deer. The star-nosed mole has star-like "feelers" on its nose. The water shrew lives in or near the water.

Small mammals can be put into 4 different categories. Mice have large ears and long tails. Voles have large ears and short tails. Shrews have tiny ears and pointed noses, and moles have tiny ears, huge front paws and a fat tail.

Habitats

Livetraps will be set in a number of habitats. Boreal red-backed voles may be found under spruce and balsam fir trees, eating seeds. Water shrews are found along cutbanks and mossy roots near a stream. They dive and capture aquatic insects. Meadow voles are found in open meadows traveling runways under the dead grass layer. They eat grasses and open field vegetation. Star-nosed moles are found in wet soil where they tunnel for earthworms and build distinctive mole-hills. Most shrews prefer moist areas for their habitats. It appears that dehydration is a potential problem with their high metabolic rates. White-footed deer mice are deciduous forest dwellers and live under aspens and birches. They have slightly longer fur than most of the other small mammals and can make periodic trips above a winter snow layer. Most of the others need the snow for extra insulation. Woodland jumping mice live in logs near a stream and have extra long tails for balance on their long (6 foot) leaps.

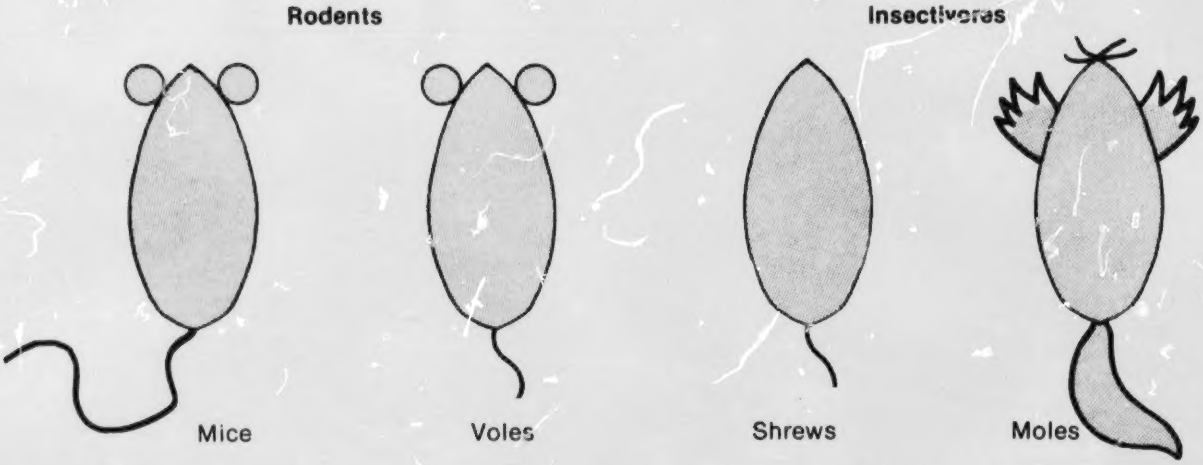
The Food Chain

The role of small mammals in the food chain is that of consumer. Primary consumers are those which consume plants. All of the rodents (mice and voles) would be in this category. Secondary consumers are those which eat primary consumers. Insectivores such as shrews and moles eat insects and other small mammals. Most of the small mammals have high metabolic rates, but the shrews' rates are astounding. They eat nearly three times their body weight in food per day. For the average adult human of 150 pounds, this would be 450 pounds of food -- today!

The reproductive rate of small mammals is equally astounding. If there were no predators, disease or food limits for meadow voles, we would be neck-deep in voles in one year -- all over the earth! Small mammals are the largest source of biological "middlemen". They eat billions of pounds of plants each year and feed countless scavengers and predators.

Sources

Mammals of Canada	Banfield
Mammals of the Great Lakes Region	Burt



Snowshoe Hare

Walking through the northwoods, you find spruce and balsam fir trees drooping under heavy loads of snow. Something moves as you pass near a thick stand of evergreens. Your eyes strain, and under a low branch you see a small black eye. A snowshoe hare materializes around the eye, motionless. You move forward slowly and at a distance of ten feet the hare jumps into a soundless run. You follow, and each time you get close the hare soundlessly moves off. Suddenly you realize that the hare is back under the original branch! The hare, and you, have made a complete circle. Thus, the camouflage and escape behavior of the snowshoe hare becomes a part of the pleasant memory of a silent winter walk.

Following an indoor session on the biology of snowshoe hares, the students will go into the forest to find and study hare behavior.

Signs
Students will be shown signs of hare activity including browse marks, tracks, droppings, urine marks, trails and hiding spots.

Nutrition
Through observation students will establish a snowshoe hare food preference list for this area. The Naturalist will discuss the role of nutrition in hypoglycemia and the periodic population crashes of hares. Hares seem to develop social stress when populations are high. This stress affects their adrenal glands and triggers a chemical chain reaction which results in low blood sugar levels (hypoglycemia). Hares are able to eat and redigest their own droppings in times of low food supply, however, hares with hypoglycemia may starve even with an adequate food supply.

Camouflage
Students will examine the camouflage and hiding behavior of hares. Hares molt from brown to white each fall, and the molt begins first near the feet and lower legs. The fall molt and the spring molt back to brown are both triggered by the length of day. Hares have behavioral camouflage also, remaining motionless until they absolutely must move. Bristly hairs pad the "snowshoes" and are standard equipment in the winter molt.

Behavior
Students will learn first-hand the escape and circling behavior of the snowshoe by finding and following one. Hares have large and sensitive ears, good noses, and eyes located on the sides of their head near the top. The location of their eyes enables them to see nearly 360° and above them for aerial predators such as owls. During March, on moonlit nights, hares do a thumping mating dance with their hind legs.

Sources

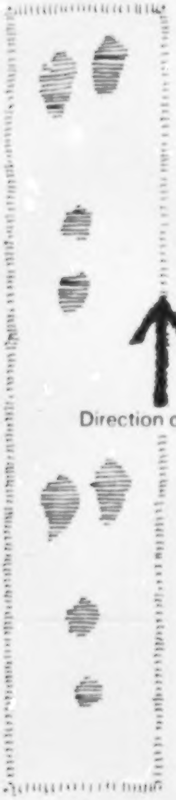
The Mammals of Canada	Banfield
Mammals of the Great Lakes Region	Burt

Glossary

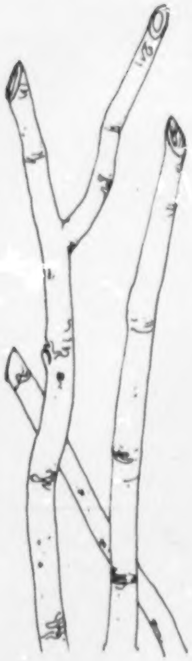
Hypoglycemia	Low blood sugar caused by the inability of the liver to break down fats
Adrenal Glands	Glands found near the kidneys of most mammals which produce adrenalin in

	reaction to emergency or stress
Molt	Loss and replacement (usually annual) of feathers or hair in animals

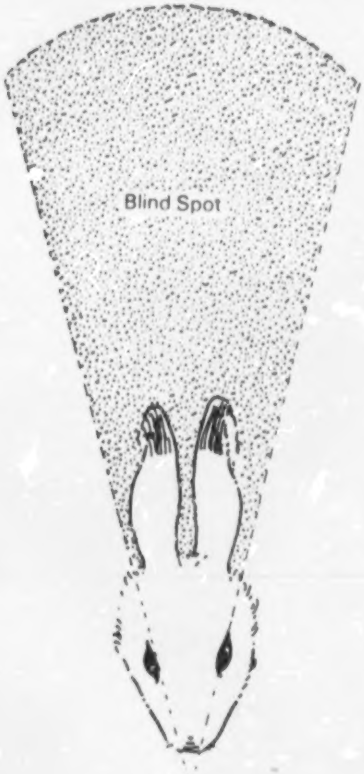
Hare Tracks



Hare Browsed Twig



Area of Vision



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Spring Warblers

Sunrise finds you in a black spruce bog. Little darts of color flit from branch to branch among the conifers, mostly hidden, sometimes ignited by shafts of new sunlight. Binoculars bring the darts into sharp focus. Your eyes must dance behind the lenses, trying to keep the feeding warblers in the field of view. Occasionally an especially colorful male will stop, pitch its head backward and gargle a high-pitched song, announcing ownership. As they sing, patterns become apparent. Certain songs come from the deciduous trees on the edge of the bog and some from the tall spruces. Careful observation indicates a vertical arrangement of birds in the trees. Certain songs are heard at the treetops, others halfway down, and still others near the ground. Each species has its own niche within the habitat.

Following an indoor session on warbler song and sight identification (using flashcards,) students will go into the forest to observe warblers. The concepts of habitat and niche will be clearly understood when observed in a natural setting.

Identification

Warblers are small-billed active insectivores that can be identified by sight, song and habitat. All warblers "warble" and each has its own distinct song. More often than not the first indication of a warbler's nearness is its song. Parula warblers sing a buzzy song from the very tops of deciduous trees. Black-and-white warblers sing frail-sounding songs as they crawl up and down the lower trunks of trees. Recognizing individual songs and understanding where within a habitat various species are typically located (in the tops of trees, along lower trunks) enables a viewer to pinpoint the birds' location.

Habitat and Niche

A black spruce bog provides a habitat for all of the plants and animals that live together in a bog. In the sea, the tidal zone is a habitat as are the low shallow offshore regions. The bay-breasted warbler has the same habitat as the cape may warbler. However, they do not conflict with one another because within the habitat they each have their special niche. A niche is more a role than a place. The niche of any species is its position within the community that occupies a habitat - where and what it eats, who its predators are, where it nests, and when it is active. It is a basic assumption of ecology, well supported in the case of warblers, that no two species will occupy the same niche in a community at the same time. The bay-breasted warbler and the cape may warbler share the same middle layer of coniferous trees in the bog. The bay-breasted prefers to eat spruce budworms and the cape may prefers flying insects. They each have a different niche within the same habitat.

Sources

Habitat Guide to Birding	McElroy
Field Guide to Birds [Eastern Region]	Peterson
Birds of North America	Robbins

Glossary

Community The plants and animals that occupy the same habitat.

Warblers A family of small insect-eating birds which nest largely in the northern coniferous forests.

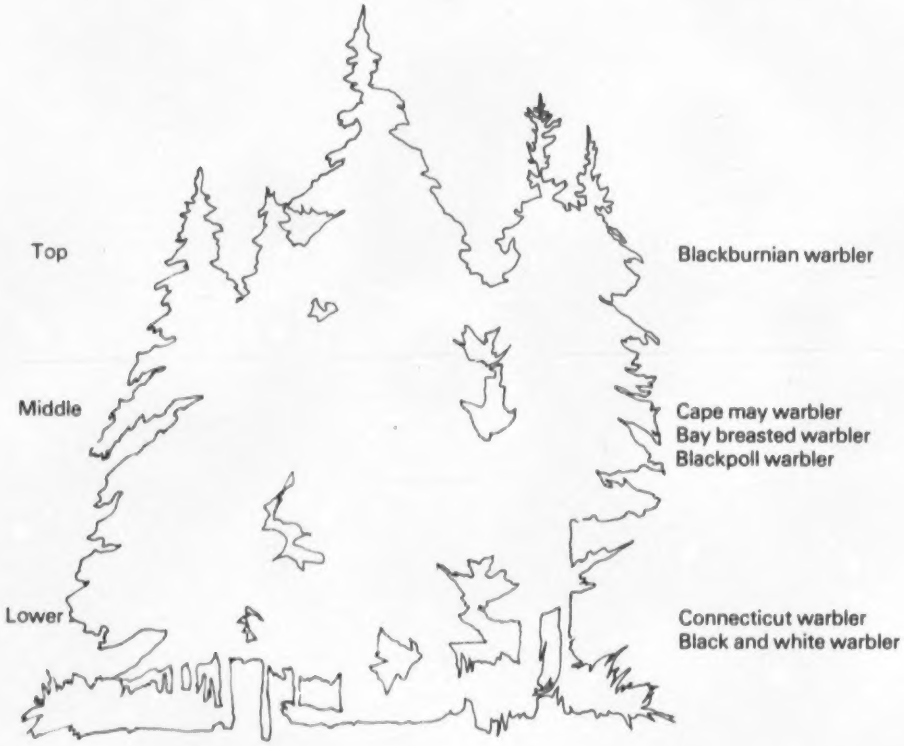
Territory A breeding area which has strict boundaries between members of the same species of warbler.

Species Individuals who can breed and produce fertile offspring are considered a species.

Habitat A "neighborhood." In spite of the adaptability of most organisms, they usually inhabit a specific habitat.

Niche An animal's "job" or role in a community of organisms living within a habitat is that animal's niche. Characteristics of niche are mostly behavior patterns.

Vertical Stratification of Warbler Habitats in Black Spruce Bogs.



Spring Wildflowers

Wildflowers are pretty and most often they smell very nice. People enjoy seeing and smelling wildflowers. Their real function, however, is much more serious for without the flower there would be no plant. Flowers are attractive to people but their primary job is to attract insects. The insects, seeking the nectar produced by the flower carry pollen grains from plant to plant initiating reproduction. The production of nectar for the insects that carry the pollen grains which fertilize seeds is a classic example of mutualism. Both organisms, the insects and the plants, benefit.

Students will design an identification key for the wildflowers they encounter and will learn the reproductive parts of flowers during the process.

Reproduction
Flowers have a number of parts that are universal, although sometimes they are separated into male and female components. Occasionally some parts are missing or very small.

The future seeds of plants are contained in chambers, called ovaries, of the female part of the flower which is called the pistel. The pistel usually has a long extension tube called the style. The end of the style is called the stigma which is covered with a sticky material which captures the male pollen grains which fertilize the seeds contained in the ovary. The male part of the flower is called the stamen and consists of the anther, where pollen is produced, and the filament, which supports the anther.

Flowers that contain both male and female parts are able to pollinate themselves. Nature, however, favors those organisms which can change with their environment. Cross pollination, frequently using insects to carry pollen from one plant to another, mixes genetic traits and results in plants that are more hardy. Being hardy within a changing environment results in a better chance of survival.

Identification
Flower parts are frequently arranged differently in different species. Three sepals, three petals, six stamens and three carpels is the formula for members of the lily family. Understanding arrangements, color, size and location will help make identification an easier task. The following are common Northern Minnesota spring wildflowers:

In openings: Juneberry, pinchberry, dandelion, stawberry, graywings.

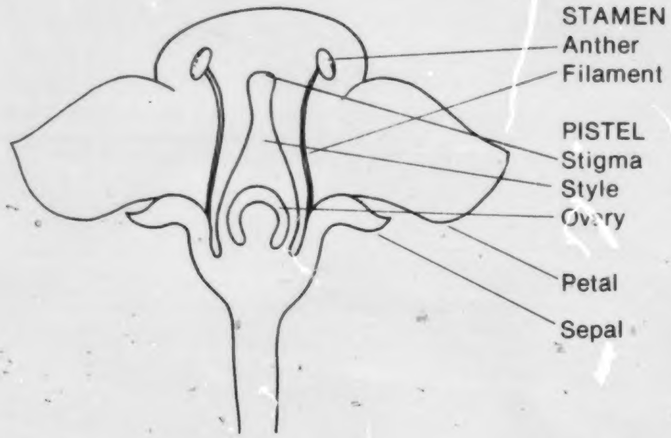
In bogs: leatherleaf, bog rosemary, bog laurel, Labrador tea

In the forest: violet, bunchberry, starflower, wild ginger, goldthread, wood anemone, wild lily-of-the-valley, nodding trillium, mertensia, clintonia

Sources

A Flora of Northern Minnesota	Lakela
Field Guide to Wildflowers	Peterson
Spring Flora of Minnesota	Morley

Parts of a Flower



White Tailed Deer

It is autumn. You steal along a narrow winding trail through the thickest part of the woods. Ahead you see a small sapling whose bark has been rubbed to shreds. Just off the trail is a large area of ground that is covered with deer tracks and has all of the leaves and branches pawed away. A snapping twig draws your attention to the densest part of the forest in time for you to see the brown and white, ghost-like figure of a white tailed deer slip away.

Following an indoor session on the white tailed deer, students will go to the forest and study evidence dealing with the behavior, physiology and habitat of the deer.

Physiology and Food Sources

Students will be introduced to the physiology of the deer in the classroom and examine food types in the forest. The white tailed deer molts into a better camouflaged winter coat each fall and the winter hair is hollow, which provides greater insulation from the cold. Many of the body processes seem to slow down in the winter; this slowdown is frequently described as "walking hibernation". Winter foods include browse of aspen, dogwood and mountain maple as well as usnea lichens.

Reproduction

Students will study the reproductive behavior of the deer and then look for signs of this behavior in the forest. Buck deer rub the velvet from their antlers on small saplings. These rubs serve to advertise their own size as well as define their territory. Scrapes on the ground attract does for mating, and the buck will usually visit a scrape at least once each day. Normally the strongest bucks mate with the most does, and the result is a strong fawn crop. Twin and triplet fawns are common following less severe winters.

Habitat

Students will examine deer sign and make generalizations on the deer's habitat. They will also look for food and water sources, cover and bedding areas.

Escape and Feeding Behavior

Deer seem to be creatures of habit, but capable of changing habits quickly to protect themselves. They prefer to bed down on the upwind sides of openings, enabling them to catch scents coming from the woods and to see into the opening, thereby covering most of the approaches of predators. They have circular daily patterns to and from feeding areas, are crepuscular in their feeding, and change their habits to fit moon phases, weather and wind direction. They escape up and over hills, into thick brush and into the wind. Their tails act as a danger or all-clear signal for other members in their group. Students will attempt to find deer and observe some of these behavior patterns.

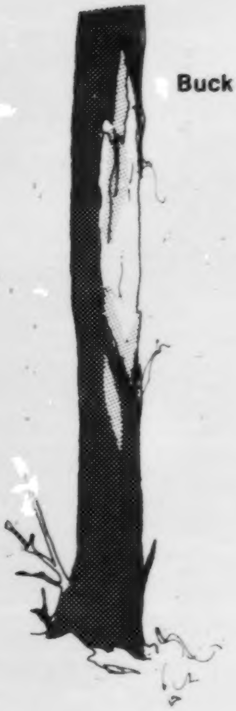
Sources

The Mammals of Canada	Banfield
Bowhunting for Deer	Wambold

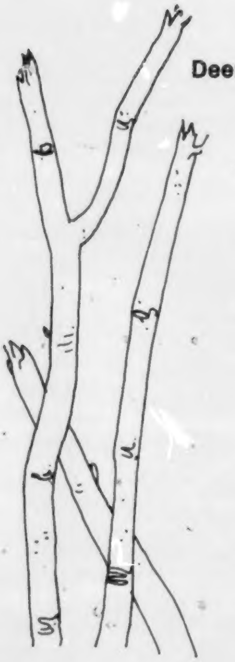
Glossary

Rub	area of bark rubbed by a buck deer - usually a deciduous sapling
Scrape	area of ground scraped clean by a buck deer to attract does
Torpor	the slowing down of body functions

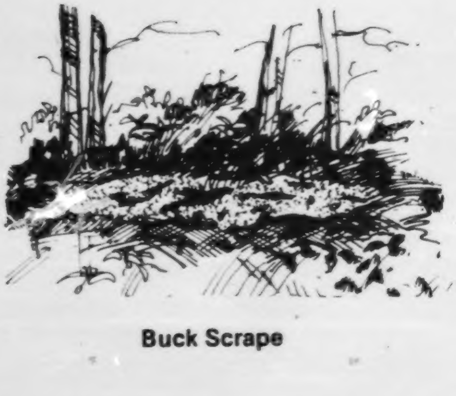
Physiology	the internal body processes
Crepuscular	active at dawn and dusk
Territory	an area defined by an animal belonging to that animal or the group of which the animal is a member



Buck Rub

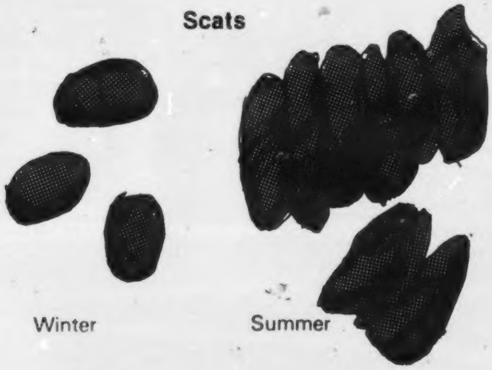


Deer Browse



Buck Scrape

Scats



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Winter Plants

It's 40 below. The snow squeaks and crunches beneath your feet on the trail. The eastern sky is just turning pink and lavender. Aspen tangles and spruce spires are etched against the early morning sky -- they seem stark, lifeless. High in the aspens a prickly ball gnaws on a branch. Porcupine. A grouse explodes from a spruce tree, starting a landslide of snow from branch to branch. It lands in the aspens and begins to nibble on next year's male flower buds. Despite numbing feet, you stand motionless. A white tailed deer ghosts through the fallen budworm-killed balsam trees, lifting its feet high for silent placement in the snow. It stretches to eat beard lichens, which cover every dead branch in the forest. The interrelationships of plants and animals are observable, even on a crisp winter morning.

Using a classroom session on winter plant identification and a hike on a nature trail, students will learn the interrelationships of winter plants and animals.

Identification
Students will learn to identify the common area trees, shrubs and herbaceous plants of winter, using a special key and a "charades" game. Deciduous plants will be identified by their bark and buds in winter.

Plants as Food
Students will find and examine a number of plants that are used by animals for food. Spruce budworms eat new foliage of spruce and balsam fir trees. Deer browse on mountain maple, dogwood, aspen, cedar and usnea lichens. Grouse eat male aspen buds in the tops of trees. Porcupines prefer white pine or aspen bark, and hares browse on aspen, balsam fir, and hazelnut twigs.

Plants as cover
Students will learn how animals use plants for protection from weather and predators. Animals must have safe places to sleep. Grouse roost in conifers near the trunk or in snow. Procupines "roost" in hollow trees. Owl roosts can be found by looking for whitewash (droppings) on lower branches and trunks of trees. Deer trails to food sources usually meander through extremely thick brush for protection from predators. In snow or ice storms, thick conifers are necessary to protect animals from weather.

Winter Plant Physiology
Students will learn the physiolgy and other adaptations of plants to the winter environment. Winter is a time of drought, so many plants store food in root systems. There is no movement of liquids up and down trunks in winter, so there is no growth. Many leaves drop off and seal the wounds with leaf scars, preventing water loss. Maples do not grow in extemely cold climates because they are subject to sap-runs in a temporary thaw. Re-freezing expansion rips their trunks open violently. Conifers have small waxy leaves and resilient pitch-filled trunks, advantages in a cold climate. Trees grow next year's buds, and branch shapes for gathering sunlight are apparent only in winter.

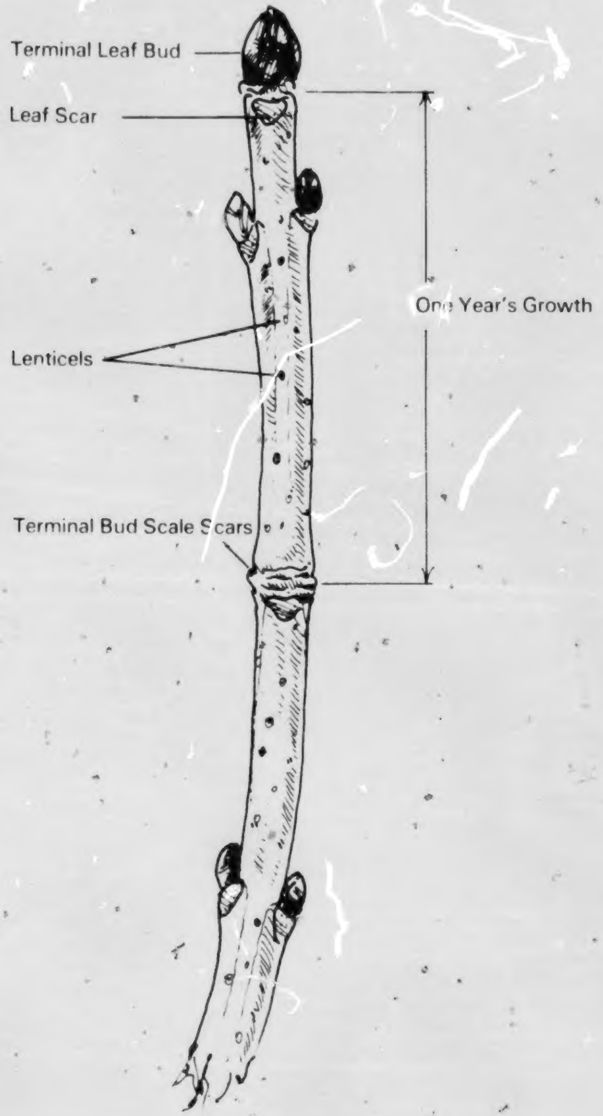
Sources

Trees of Eastern U.S. and Canada	Harlow
American Wildlife and Plants	Martin, Zim, Nelson
A Guide to Nature in Winter	Stokes

Glossary

Lichen	Mutual "living together" of fungus and algae
Browse	Twigs, buds and bark eaten by animals
Roost	Sleeping place of an animal
Transpiration	Water escape from chemical processes of leaves
Dispersal	How seeds are spread about for maximum reproduction

Parts of a Winter Twig



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Tree and Shrub Ecology

Trees stand tall and straight. It seems that they never change, only swaying in the wind, losing and regrowing leaves. At the edge of the open fields, shrubs and then smaller trees seem to be marching in from the heavier wooded areas. The aspen and birch community within a boreal forest of one hundred years ago is likely gone now, replaced with balsam fir and spruce that grew among them and then, when mature, starved them of sunlight. Some trees grow only near the water, and others only on certain soils. The geographical distribution of plants depends not only upon very apparent indicators such as location and soil type but also on the effect of plants, during stages of their growth, upon one another.

Students will learn to recognize a number of common trees and shrubs as well as understand the concept of the biome, community and succession with common interruptions.

Identification
Using a key, students will learn to recognize "communities" of trees by their individual members, as well as recognize the factors within the habitat that have resulted in the community. PINES, red white and jack, grow best on well drained mineral soils. ASPEN and BIRCH grow best on damp highland areas with the birches preferring an organic soil. CEDAR, ELM and BLACK ASH are wetland trees and BLACK SPRUCE and TAMARACK are right at home in bogs. BEAKED HAZEL grows in high open areas and RED OSIER DOGWOOD prefers shade. PIN CHERRIES grow in waste areas and CHOKE CHERRIES near the forest edges.

Communities
Understanding the plant indicators of a forest community, students will go on to study and observe the total habitat of each community. The spruce-balsam fir community is known as a CLIMAX FOREST because, without an interruption, they replace themselves forever. The aspen-birch community will, with direct sunlight, outgrow all competition and flourish until such time that a climax communty, which does well without direct sunlight, grows taller and robs the aspen and birch of the needed sunlight. Pine communities, consisting of red, white and/or jack pine require an unusual set of conditions in order to develop. Because they need direct sunlight, grow slowly and only in primarily mineral soil, pine communities are best started with help of man, or, if permitted, a very hot fire.

Succession
Succession is the predictable sequence of changes in the plant species that inhabit an area. As succession progresses, bare land eventually becomes grassland or forest; at a certain point, the vegetation becomes stable and is called the climax stage. Students will learn to define succession as well as recognize predictable stages of succession.

Interruptions
At times natural succession is interrupted. Students will learn of the role of fire, disease and man as interruptors of natural succession. Fire, eliminating both the shade trees and the organic topsoil of an area provides an ideal situation for the beginning of a pine community. Diseases, such as the spruce budworm, open the canopy also, however, the organic soils remain and thus regeneration in aspen and birch is most likely. Human interruptions, such as logging, will result in a natural aspen-birch regeneration unless the area is scarified (topsoil scraped away with a bulldozer), replanted in pines and then herbicided to prevent aspen regeneration.

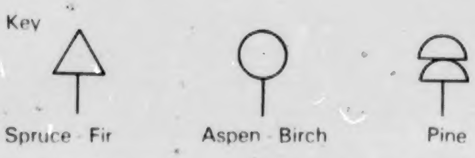
Sources

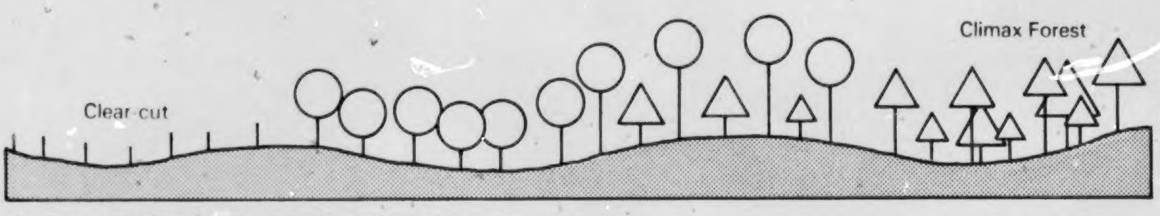
Trees of Eastern U.S. and Canada	Harlow
Field Biology and Ecology	Smith

Glossary

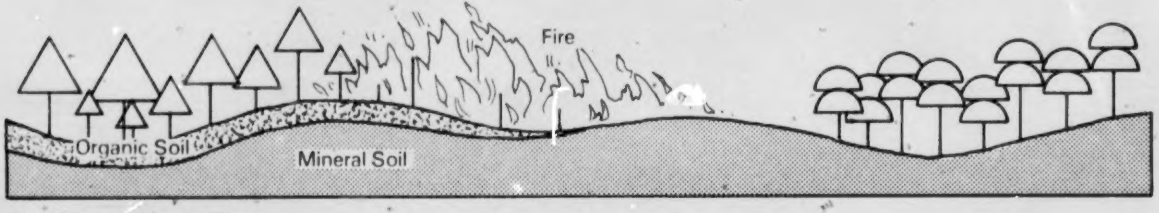
Climax Forest	a forest that regenerates itself
Habitat	the place an animal or plant lives
Mineral soil	non-organic soil consisting mainly of ground rock
Organic soil	soil consisting mainly of decomposing vegetable matter
Succession	the predictable sequence of changes in the plant species of an area
Herbicide	plant poison
Scarify	logging term meaning to scrape away topsoil
Clearcut	logging practice of removing all trees in an area
Biome	a broad ecological unit consisting of distinctive group of plants and animals. The desert is a biome as is the mixed forest consisting of deciduous and coniferous trees located in northern Minnesota
Community	is the term used to define the plant and animal members of a specific habitat type

Forest Succession





Northeastern Minnesota Succession Following Logging



Pine Regeneration by Fire

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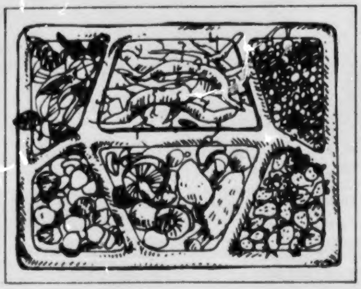
Wild Edible Plants



Prior to large supermarkets and rapid transportation, most people use gardens. Native Americans used gardens too, but frequently most of their food consisted of wild plants and animals. Foods that are today considered domestic were all wild in times past. Many domestic plants were native to places other than where they may be found now. Many people are "returning" to nature and the wilderness image by harvesting wild foods.

Students will learn about the nutrition cycle within the food chain. Wild edible plants will be identified, collected and prepared.

A Food Chain

Every living thing depends on the sun but only plants use the sun's energy directly. Through the process of photosynthesis they convert the sun's energy to food. Animals eat the plants and other animals eat the animals that were nourished by the plant. Because the prey-predator relationships are not predictable, the food chain is sometimes spoken of as the food web. Insects are normally eaten by insectivores but they are also eaten by everything from people to bears. It is important to remember that the sun powers the food chain and the energy cycle within the chain. Plants are the primary food producers and provide the food basis for all life.

Plant Identification

Plant identification is extremely important as most of the really tasty wild plants have already been domesticated. Frequently wild plants are poisonous or they just plain aren't very tasty! The Jerusalem artichoke, a member of the sunflower family, is the only sunflower which has a highly edible root. Also called the Canada potato, the root served the same purpose as the common potato does now. Nuts, roots, tubers, greens, seeds and teas may all be gathered free from the land if positive identification precedes cooking and eating. Common wild edibles which may be identified and prepared in season include the following:

Potherbs
Fern fiddleheads
Cow parsnip
Evening primrose
Marsh marigold
Water lily
Burdock
Dandelion
Stinging nettle
Lamb's quarter

Salad Fixin's
Violet leaves
Plantain leaves
Dandelion leaves
Cattail roots
Creeping snowberry
Columbine
Clover leaves
Clover flowers

Teas and Drinks
Labrador tea
Rose hips
Raspberry twigs
Strawberry leaves
Goldenrod flowers
Sweet gale
Sumac berries
Pine needles

Syrups
Maple
Birch
Bunch berries
Sumac berries

Grains
Wild rice

Fruits
Blueberry
Raspberry
Choke cherry
Strawberry
Pin cherry
June berry
Bog cranberry

The food value of wild edible plants is often equal to that of domestic plants. One rosehip has twice as much Vitamin C as an orange. Many gardeners spend hours frantically eliminating a weed called lamb's quarter from their gardens. Yet lamb's quarter is tastier, higher in protein and vitamins and more resistant to infestations than most of the cultivated plants.

Cooking Wild Plants

Knowing how to prepare wild foods is almost as important as how to recognize those that are edible. Marsh marigold leaves, milkweed pods and water lily roots all taste terrible unless boiled three times, each with new water, to remove bitterness. Burdock root turns an ugly purple when prepared in a metal pot. Stinging nettle contains an irritant skin poison when fresh, but is safe and very tasty when boiled and mixed with a cream sauce.

Ethics

Only foolish harvesters take all of the plants in an area for then it becomes a one season harvest only. A proper rule of thumb for those plants which can be harvested is "pick one and leave ten" for reproduction. Rock tripe is edible but very slow growing. Like most lichens, rock tripe may be hundreds of years old. Lady-slipper stalks and leaves are tasty but also unique. When it is realized that the lady-slipper takes up to twenty years before it flowers, it can be understood that the best way to enjoy a lady-slipper is just to look at it.

Sources

A Field Guide to Edible Wild Plants	Peterson
Grazing, a Wildeater's Cookbook	Link
A Field Guide to Wildflowers	Peterson

Glossary

Edible is a condition of plants which states that it can be eaten. It has no relationship to the word tasty.

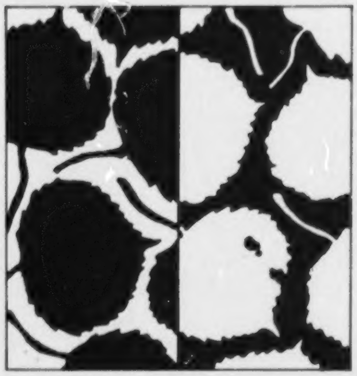
Food Chain is a linear consumption of energy starting with the sun.

Primary Producers are plants which produce food from sunlight, carbon dioxide and water.

Primary Consumers are animals which eat plants, or, sometimes, parasitic plants.

Secondary Consumers are animals which eat the primary consumers, usually predators or parasites.

Fall Plant Transitions



The fire-like reds and yellows of autumn leaves are impressive. It's difficult to believe that such bright colors have always been present in the leaves, but they have. Chlorophyll, the green summer pigment, masks red xanthophylls and yellow carotenes. The short days and cool nights of early fall trigger a hormone change, and chlorophyll is broken down. The change in day length also triggers a building of abscissic acid, which hardens cells at the base of a leaf stalk. The leaves rapidly turn brown and crackly, raining down on the forest floor. Plants must change to meet the rigors of the harsh north woods winter.

During a half-day hike, students will study the transitions of plants from summer to winter.

Leaf Pigment Physiology
With careful observation, a phenology of color changes is possible to study. Different plants change color at different times. Some aspens, for instance, drop their leaves before other aspens have turned yellow. This represents nature's experimentation to find the most efficient timing. Eventually the early or late trees will die, leaving the best for this climate.

Internal Physiology
In general, the deciduous (lose leaves every year) trees must change in a number of ways to adapt to winter. Water must be stored below the frost line in roots or mixed with "antifreeze" sugars. Growth stops in winter — there is no movement of fluids and no leaves to produce food. Leaves fall off because of abscissic acid buildup, and cork layers immediately cover the leaf scars on twigs. Fungi retreat to their root system, or mycelia, and all visible parts die away. Lichens and mosses simply freeze after they rid themselves of excess water.

Seed Dispersal
Seeds are dispersed by air, water and animals. Air-dispersed seeds usually have wings or fuzzy parachutes to enable their movement for long distances. Water-borne seeds have air bladders or a large surface area to promote surface tension. The types of trees which have water-borne seeds usually grow near the water. There is little way to get their seeds to high land. Animals disperse seeds in two ways. Burrs and beggar-ticks stick to hair and clothing, riding on animals to a new home. If you were to look at a bear dropping, the second way would be obvious. Many droppings contain indigestible seeds, and those seeds have their own fertilizer when they are dropped!

Sources

Trees and Shrubs of North America	Harlow
Botany	Wier, Stocking, Barbour
Seed Dispersal - Adaptation	OBIS - U of California, Berkeley

Glossary

Chlorophyll	Green energy-producing pigment in plants
Carotene	Yellow pigment in plant leaves
Xanthophyll	Red pigment in plant leaves
Phenology	The study of the timing of natural events
Abscission	The severing of leaf-stalks from a twig

Xylem	Water carrying tissue in plant stems
Phloem	Food carrying tissue in plant stems
Mycelium	Rootlike main body of a fungus
Mutualism	A partnership or sharing between two organisms in which both benefit

Seed Dispersion Methods

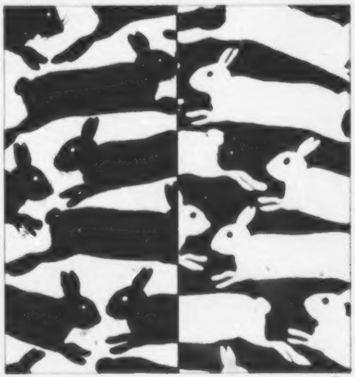
Wind

Water

Animals
(eaten and left in droppings)

Animals
(attached to coat)

Fall Animal Transitions



As days shorten and leaves fall to earth, animals undergo changes in their physiology. The external changes are obvious. Hares change their color to white, deer grow long hollow hairs for insulation, and beavers actively cut trees and build food piles. There are inner changes in animals, too. Hare and deer droppings change texture because of the change to woody foods. Insects become dormant, spin cocoons, pupate or die after they lay eggs. The north woods winter is severe, and animals who do not adjust simply die.

With a classroom introduction and a hike, students will learn the adaptations and short-term changes animals must make to survive the north woods winter.

Food Habits

Beavers increase their tree-cutting activity tremendously in the fall. Their stockpile of sticks, buried in mud outside the lodge, must feed them throughout the winter. Deer and hare make a transition to woody foods because greenery is not available in the fall. Hares snip twigs cleanly with their sharp teeth and their droppings reflect what they eat (they look like compressed sawdust). Deer twist off twigs with dull teeth. The resulting exposed end is rough and frayed. Deer droppings change from soft to hard bean shapes in the winter. Grouse dine heavily on male aspen flower buds, the availability of which has much to do with their survival rate.

Animal Movements

During late October and early November, male whitetail deer go into the rut and begin their mating behavior. They rub small trees with their antlers to rid the antlers of velvet, strengthen neck muscles and mark the edges of their territory. They make large scrapes on the ground, urinating on the scrape via the tarsal glands on the insides of their hind legs. The combination of smells on bare earth attracts does for mating. Because bucks are rather singleminded during the rut, their trails are often straight lines from scrape to scrape.

Male grouse drum in the autumn to mark their territory claim. Young grouse disperse in the early fall by flying wildly for long distances. This crazy flight time is when many grouse fly into windows and moving cars. Hares move to thicker coniferous areas when the leaf cover of deciduous trees falls to the ground. Spiders climb to the tops of trees and spin a long thread into the wind. Then they simply let go, and their gossamer wing parachutes take them to a new area, sometimes miles away.

External Changes

Snowshoe hares molt to a white coat, taking seven weeks to change color. The trigger is photoperiod, the length of the day. If snow is not present until late in the fall, hares stand out in their white coats and suffer high mortality. Deer molt and grow long hollow hairs for insulation. Many people have remarked how fat deer look in the winter, because of their long hair. Grouse grow projections on the sides of their toes in winter. These serve as snowshoes for walking atop the deep snow and give them better traction on icy branches.

Hibernation and Dormancy

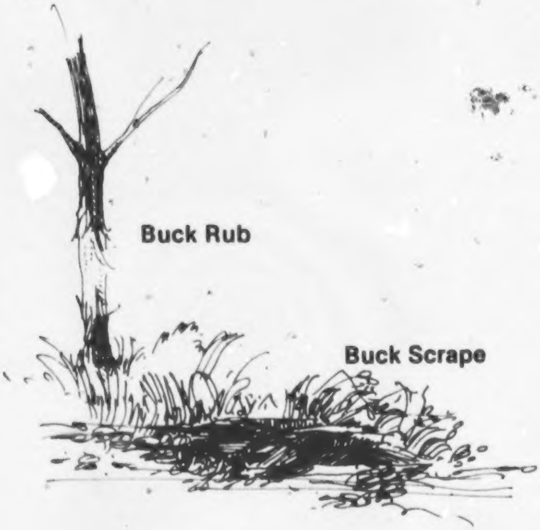
Insects spend the winter within cocoons, as pupas and eggs, or simply become dormant. This dormancy is carried to an extreme by the seventeen-year cicada, which come out every fifteen to eighteen years. Chipmunks and ground squirrels are true hibernators. Their heartbeats are sometimes as slow as one per minute and body temperatures hover just above freezing. Bears are not true hibernators. They can wake up quickly from their state of "torpor" or deep sleep. They lose nearly half of their body weight sleeping away the winter.

Sources

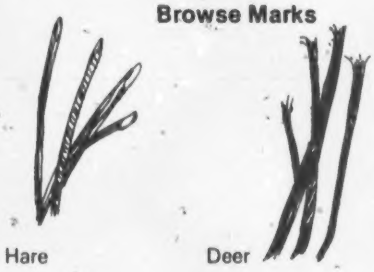
Mammals of Canada	Banfield
Mammals of the Great Lakes Region	Burt
The Ruffed Grouse	Gullion (Minnesota Volunteer 9/78)
Insects	Golden Guide Series
Spiders	Golden Guide Series

Glossary

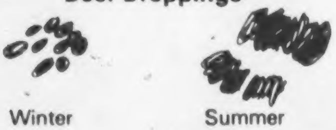
Pelage	An animal's coat or covering
Scrape	Area of ground scraped clean by buck deer, scent marked to attract does
Rub	Area on small sapling where buck deer removed velvet from antlers
Browse	Twigs and buds eaten in fall and winter
Food Cache	Pile of sticks buried in mud outside a beaver lodge, winter food supply
Covert	An area of cover for a small animal
Dormancy	Slowing of body functions
Hibernation	Spending winter in state of suspended animation



Browse Marks



Deer Droppings



Beaver Cutting

ACTIVITY SITE MAP

- Trails
- **Plant Photosynthesis / Tree Adaptations to Winter** sites
- **Great Key Race** sites
- **Forest Communities / Bird Identification** sites
- Open Areas
- Forested Areas
- Bogs
- Swamp
- Burned Over Area